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Coastal and Hydraulics Laboratory



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Physical Model Test for Bendway Weir Design Criteria

Waterway Simulation Technology, Inc.

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Contents

1—Introduction.....	1
Background.....	1
Study Approach	1
2—Design	2
Existing Bendway Weir Project Design Method	2
Data Analysis.....	3
3—Bendway Weir Field.....	10
Constructed Bendway Weir Systems	10
Greenfield Bend.....	10
Eliza Point	11
Scudder's Landing.....	12
Dogtooth Bend.....	13
Price's Landing.....	14
Cape Bend	15
Cape Rock	16
Picayune	16
Fountain Bluff	17
Red Rock	18
Kaskaskia Bend	19
St. Genevieve.....	20
Fort Chartes	20
Establishment	22
Carl Baer.....	23
Bellerive	24
Mosenthein/Chain of Rocks Canal	25
Victory Bend.....	26
4—Post Construction Analysis.....	28
Pilot General Comments.....	28
Unconstructed Bendway Weir Systems	29
Analysis of Reported Accidents.....	29
Summary of Survey Results.....	31
Navigation Changes Due to Bendways.....	32
5—Test Plan Development	33
Considerations for Developing Test Plan	33

Significant Factors for Test Plan.....	34
Test Environment, Scale, and Time of Operations	35
Proposed Physical Model Test Plan.....	37
Appendix A—U.S. Coast Guard Casualty Data (1993-1997).....	A1
SF 298	

List of Figures

Figure 1.	Greenfield Bend	10
Figure 2.	Eliza Point.....	11
Figure 3.	Scudder's Landing	12
Figure 4.	Dogtooth Bend	13
Figure 5.	Price's Landing	14
Figure 6.	Cape Bend.....	15
Figure 7.	Cape Rock.....	16
Figure 8.	Picayune	17
Figure 9.	Fountain Bluff.....	18
Figure 10.	Red Rock.....	19
Figure 11.	Kaskaskia Bend.....	19
Figure 12.	St. Genevieve	20
Figure 13.	Fort Chartres	21
Figure 14.	Establishment.....	23
Figure 15.	Carl Baer	23
Figure 16.	Bellerive.....	24
Figure 17.	Mosenthein/Chain of Rocks Canal.....	25
Figure 18.	Victory Bend.....	26

Preface

The work described herein summarizes the results for physical model testing of bendway weir design criteria including conditions and design options needed for a model testing plan for determining navigation impacts.

The report was written and prepared by Waterway Simulation Technology, Inc., 2791 Burnt House Road, Vicksburg, MS. The work was monitored by the Inland Navigation Group, Coastal and Hydraulics Laboratory (CHL), U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, during the period June 1998 to September 2002. It was completed under Contract No. DACW 39-99-P-0443 in support of Research Work Unit No. 32256: Effects of Bendway Weirs on Navigation, No. 333, Inland Navigation.

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During publication of this report, Dr. James R. Houston was Director of ERDC, and COL John W. Morris III, EN, was Commander and Executive Director.

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
feet	0.3048	meters

1 Introduction

Background

During the last decade the U.S. Army Corps of Engineers has been placing structures called bendway weirs (submerged dikes) in river bends to improve stability of navigation channels and, consequently, reduce dredging. In some cases these weirs have improved navigation conditions, especially when physical models have been tested prior to construction to determine efficacy of the designs. However, for many constructed bendway weir systems either no model testing was performed or effects on tow navigation were not considered in their design. In one project physical model test, Montgomery Point Lock and Dam, some designs were tested which were shown by the model to create dangerous conditions for navigation, particularly for upbound tows. Some anecdotal stories from tow pilots concerning a few in-place weir systems have been received which claim difficult navigation conditions at various river stages. Some similar situations have been reported for submerged dike fields in lock approaches.

Study Approach

A multi-faceted approach was used to determine the range of conditions and various design options that need to be included in a model testing plan for determining navigation impacts of bendway weirs. A critical part of the effort was to identify all of the existing bendway and lock approach weir systems which have either been constructed or designed and awaiting construction. Furthermore, information concerning each of the weir systems was critical including design specifications, pre- and post-construction bottom surveys and navigation history, and flow conditions. Two U.S. Army Engineer Districts, Vicksburg and St. Louis, have designed and constructed bendway weir systems. These offices provided design materials such as as-built drawings, hydrographic surveys and flow histories for defining weir conditions. All the bendway weir systems investigated were located on the Mississippi River.

The plans, histories and designs were analyzed and categorized to define ranges of design parameters and conditions experienced at the weir systems since construction. Also, data bases were examined for these areas to identify accidents near the weir fields and conditions at the time. Questionnaires were sent to towing companies and their pilots to document incidents and opinions concerning pre- and post-construction navigation difficulties near the constructed weir fields. The companies contacted included American Commercial Barge Line, Ingram Towing, Brownwater Towing, and Midland.

2 Design

Existing Bendway Weir Project Design Method

Most of the bendway weir projects (95%) have been built in and were designed by the St. Louis District. Two of these projects were modeled, Dogtooth Bend at river mile 22 and Price's Landing at river mile 30. Dogtooth Bend was modeled both with physical and mathematical modeling and was monitored with extensive prototype measurements as the project developed through the years, including following the 1993 flood.

Since these first two projects, the other bendway weir projects have been designed with the following procedure:

- Photos of ice flows in the river are obtained and the flow patterns examined through the bend.
- Using the flow patterns of the ice in combination with the overall bend plan form, the general flow pattern would be drawn in the through the project bend.
- Based on bathymetry, the number of weirs that could physically be built would be determined. At least -25 LWRP is needed for developing a minimum 10 feet¹ structure section.
- All weirs were generally laid out at an angle 30 degrees to a line drawn perpendicular to flow (as drawn from the ice photo). However, about 3 years into implementation, the angle of the last weirs was changed to bring flow into the crossing more in alignment with the channel. The last weir was place either perpendicular or slightly angled upstream into the flow.
- All weirs were built to a -15 LWRP.

Generally these projects were designed to reduce the maintenance requirements and develop a wider channel by forcing the point bar away from the outside bank of the bend. The redirection of the flow using the submerged weirs to erode the point bar also generally improved the navigation conditions by

¹ A table of factors for converting non-SI units of measurement to SI units is presented on page vi.

creating a more evenly distributed flow field. However, each weir field is unique and the development of the channel was dependent on the bed and bank conditions as well as the flow field. Some weir fields contain underlying rock strata, clay, and other non-erodible material that give a different bed response.

Data Analysis

For each weir system hydrographic survey sheets were used to identify certain design specifications. Hard-copies of the survey sheets were used to measure channel width and bend angles and to choose locations for tangents on the outside of each of the bends. Additionally, most of the weir systems had high resolution dredging survey data in CAD format which allowed close inspection of bottom contour details. For standardization, the bends were assumed to be circular and the tangent coordinates were used to calculate chord distances and bend radii. Because of the engineering judgment required for these measurements, the bend parameters identified in this report for the weir systems are approximate and should serve only as nominal values.

To establish a comparative measure of the effect of weir construction on the river bottom elevation, pre- and post-construction surveys were examined for minimum elevations immediately downstream of each of the weirs (or proposed weirs for the pre-surveys). Minimum elevations chosen from the CAD survey drawings were based on engineering judgment and represent approximate values for the purpose of before and after comparison. Weir height presented in this report is the vertical distance between two locations, one being the deepest point just downstream of the weir and the other being the top of the weir. To determine the orientation of the weirs with the upstream direction, a circular arc with the calculated radius was graphically placed over the dredging contour drawings and the angle formed at the intersection of the arc and each weir was measured. The distance between weirs was the length of a line from the end of the weir on the outside of the bend to the perpendicular intersection with the next weir downstream.

According to St. Louis District engineers all the weirs constructed in the middle Mississippi River have a top elevation of -15 ft below Low Water Reference Plane (LWRP). The weirs designed and constructed in the Vicksburg District had a weir-top elevation of -20 ft LWRP. Using these values and historical river stage records from gauging stations along the applicable reaches, the range of water depth over the weirs was calculated. Data from the gauging stations between River Mile (RM) 196 and RM 2 on the middle Mississippi and the gauging station at Arkansas City on the lower Mississippi were used to determine these depths. The 10th and 90th percentile, average, and minimum and maximum water depth over the weirs were calculated using the cumulative distribution from the river stage records and interpolating to the bendway weir system locations (for the Middle Mississippi). At Victoria Bend on the Lower Mississippi the stage record at Arkansas City was used to calculate water depth, after adjustment for the correct LWRP elevation at the weirs.

To document opinion of the navigation impacts of weir construction questionnaires were sent to tow pilots from several towing companies. The pilots were asked to give ratings to four questions aimed at determining whether tow navigation had been improved or degraded following construction of individual weir systems. Furthermore, anecdotal comments and opinions were elicited from the pilots to help identify navigational problem areas. Table 1 shows the questions asked and tabulates average ratings received from the pilots for most of the bendway weir systems. Pilot comments are included in the following section.

For this study seventeen weir systems constructed on the Middle Mississippi were investigated and one on the Lower Mississippi. Two weir systems on the Lower Mississippi are currently being designed; however, proposals for these systems were not final during the present study and little definitive information was available for the purpose of investigating navigation impacts. Details of each of the bendway weir systems are discussed below, including pilot comments directed at the specific location. Table 2 is compendium of design specifications for all the constructed weir systems.

TABLE 1 - Pilot Average Ratings for Bendway Weirs

BEND	Difficulty of Controlling Tow in Bend										Erratic Control Upbound?				Flanking Required Downbound?				Normal Speed Upbound			
	1 = Easy 10 = Very Difficult										Post Construction?				0 = Never 1 = Sometimes 2 = often 3 = Always				1 = 2-3 mph 2 = 4-5 mph 3 = 6-7 mph 4 = 8-10 mph			
	Downbound					Upbound					1 = Yes 2 = No				High Flow Low Flow				High Flow Low Flow			
	Pre	Post	Low Flow	High Flow	Post	Pre	Post	Low Flow	High Flow	Post	High	Medium	Low	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Greenfield	4.4	4.3	4.8	4.7	3.8	3.6	4.1	4.7	1.8	1.5	1.5	1.5	1.5	1.3	1.2	2.4	1.9	1.6	2.3	1.7	1.9	1.6
Eliza	2.4	2.4	2.9	2.7	2.3	2.6	2.4	2.9	2.0	2.0	2.0	2.0	1.9	0.1	0.1	0.3	0.1	0.1	1.8	2.0	1.8	1.8
Scudders	4.3	3.4	5.0	3.9	3.3	3.4	3.9	4.3	1.7	1.6	1.6	1.6	1.6	1.1	0.7	1.8	1.6	1.8	2.0	1.9	1.6	1.8
Dogtooth	4.5	4.4	5.4	4.8	3.5	3.6	4.2	4.5	1.5	1.4	1.4	1.4	1.4	1.0	0.5	1.6	1.1	1.7	1.4	1.8	1.6	1.6
Price's Landing	4.2	3.8	4.7	4.1	3.8	3.6	4.0	3.1	1.9	1.8	1.8	1.8	1.8	0.7	0.4	1.2	0.7	1.9	1.8	1.8	1.8	1.8
Cape Bend	3.5	3.4	3.9	3.7	2.9	2.7	3.7	3.1	1.9	1.9	1.9	1.9	1.9	0.7	0.3	1.3	0.8	1.9	1.8	1.8	1.8	1.9
Cape Rock	4.1	4.3	4.7	4.6	3.6	3.3	4.1	3.7	1.6	1.5	1.5	1.5	1.5	0.8	0.5	1.6	0.8	1.7	1.8	1.8	1.8	1.9
Picayune	3.0	2.9	3.4	3.0	2.8	2.7	3.1	2.3	2.0	1.9	1.9	1.9	1.9	0.0	0.0	0.1	0.0	2.0	1.8	2.0	1.9	1.9
Fountain Bluff	4.2	4.2	4.6	4.6	3.4	3.3	4.1	3.8	1.6	1.5	1.5	1.5	1.5	0.9	0.8	1.7	0.9	1.8	1.7	1.7	1.7	1.8
Red Rock	4.8	3.2	6.1	4.0	4.3	3.1	4.8	3.2	1.8	1.7	1.7	1.7	1.7	1.0	0.7	1.8	1.0	2.0	1.8	1.8	1.8	1.9
Kaskaskias	4.2	3.6	4.8	4.4	3.5	3.4	3.8	3.3	1.9	1.9	1.9	1.9	1.8	0.9	0.5	1.8	0.9	2.0	1.8	1.8	1.8	1.9
St. Genevieve	4.2	3.7	4.4	3.8	3.3	3.3	3.4	2.6	1.8	1.8	1.8	1.8	1.7	0.2	0.0	0.8	0.1	2.1	1.8	2.0	1.9	1.9
Ft. Chartres	3.9	3.5	4.5	4.4	3.2	3.4	3.8	4.3	1.6	1.5	1.5	1.5	1.4	0.9	0.6	1.8	1.0	1.9	1.8	1.8	1.6	1.6
Carl Baer	3.3	2.9	3.8	3.1	3.1	2.8	3.4	2.3	1.9	1.9	1.9	1.8	1.8	0.1	0.1	0.1	0.1	2.1	1.9	2.1	1.9	1.9
Ballerive	2.5	2.1	3.1	2.2	2.2	2.2	2.6	2.2	1.8	1.8	1.8	1.8	1.8	0.1	0.1	0.2	0.1	1.8	1.8	1.8	2.0	2.0
Mosenthein	5.4	4.8	5.4	5.4	3.8	3.6	3.9	3.7	1.6	1.6	1.6	1.6	1.6	0.1	0.1	0.1	0.1	1.3	1.4	1.7	1.6	1.6
Victoria	4.8	5.0	5.6	6.2	4.4	4.2	5.2	5.9	1.5	1.4	1.4	1.4	1.2	1.3	1.2	2.4	1.6	1.5	1.7	1.5	1.6	1.5
BEND	Improvement										Improvement				Improvement				Improvement			
	Downbound					Upbound					High Flow Low Flow				High Flow Low Flow				High Flow Low Flow			
	High Flow	Low Flow	High Flow	Low Flow	Post	High Flow	Low Flow	Post	High Flow	Low Flow	High Flow	Low Flow	Post	High Flow	Low Flow	High Flow	Low Flow	Post	High Flow	Low Flow	Post	High Flow
	0.1	0.1	0.1	0.3	0.2	0.2	-0.3	-0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Greenfield	0.1	0.1	0.1	0.3	0.2	0.2	-0.3	-0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Eliza	0.0	0.0	0.3	1.1	0.0	0.0	0.0	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scudders	0.2	0.2	0.5	0.5	-0.1	0.1	0.1	-0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dogtooth	0.4	0.4	0.8	0.8	0.3	0.3	0.3	-0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Price's Landing	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Cape Bend	-0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cape Rock	0.1	0.1	0.4	0.4	0.1	0.1	0.1	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Picayune	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Fountain Bluff	1.6	2.1	2.1	2.1	1.1	1.1	1.6	1.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Red Rock	0.4	0.4	0.4	0.4	0.2	0.2	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Kaskaskias	0.5	0.5	0.6	0.6	0.0	0.0	0.8	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
St. Genevieve	0.4	0.4	0.1	0.1	-0.2	-0.2	-0.6	-0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Ft. Chartres	0.4	0.4	0.8	0.8	0.1	0.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carl Baer	0.4	0.4	0.9	0.9	0.1	0.1	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Ballerive	0.5	0.5	0.0	0.0	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mosenthein	0.4	0.4	-0.6	-0.6	0.3	0.3	-0.7	-0.7	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Victoria	0.4	0.4	0.3	0.3	0.3	0.3	-0.7	-0.7	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

TABLE 2 - Bendway Weir Characteristics

Project		Band Angle (Degrees)	Band Radius (Ft)	Min Channel Width (Ft) -10 ft Contour	Water Depth Over Weir (ft)			Weir No.	Length (Ft)	Dist. To Next Weir (Ft)	Weir Angle (Deg)	Pre-Construction		Post-Construction	
					90th Percentile	Avg Percentile	10th Percentile					Max Depth (Ft) (Below LWRP)	Weir Height (Ft)	Max Depth (Ft) (Below LWRP)	Weir Height (Ft)
Greenfield Bend	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	71	4800	340	52.2	37.2	27.5	1	617	663	68	35.8	20.8	31.8	16.8
								2	677	568	60	36.8	21.8	16.8	1.8
								3	780	716	68	38.8	23.8	16.8	1.8
								4	766	763	76	44.8	29.8	39.8	24.8
								5	686	797	72	38.8	23.8	64.8	49.8
Eliza Point	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	53	5300	900	52.0	36.9	27.3	6	551	743	71	37.8	22.8	59.8	44.8
								7	576		64	40.8	25.8	22.8	7.8
								1	559	947	61	37.5	22.5	25.5	10.5
								2	529	350	72	39.5	24.5	37.5	22.5
								3	587	570	77	53.5	38.5	45.5	30.5
Scudder's	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	76	7500	900	51.3	36.3	26.9	4	755	600	70	37.5	22.5	35.5	20.5
								5	724	657	67	58.5	43.5	28.5	13.5
								6	530	890	66	51.5	36.5	46.5	31.5
								7	533	357	65	37.5	22.5	26.5	11.5
								8	533		66	35.5	20.5	18.5	3.5
Dogtooth Bend	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	108	8400	520	50.8	35.9	26.6	1	438	295	60	29.9	14.9	Not Available	
								2	435	368	63	27.9	12.9		
								3	584	352	55	54.9	39.9		
								4	450	276	50	48.9	34.9		
								5	445	268	42	68.9	53.9		
Price's Landing	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	68	5500	620	51.1	36.2	27.0	6	447	274	42	63.9	48.9	Not Available	
								7	446	338	45	54.9	39.9		
								8	465	421	42	43.9	28.9		
								9	552	430	51	30.9	15.9		
								10	550		55	32.9	17.9		
Price's Landing	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	68	5500	620	50.8	35.9	26.6	1	641	1252	57	35.7	20.7	20.7	5.7
								2	559	1487	58	35.7	20.7	35.7	20.7
								3	555	1507	75	49.7	34.7	49.7	34.7
								4	967	687	70	51.7	38.7	51.7	38.7
								5	912	728	66	69.7	54.7	69.7	54.7
Price's Landing	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	68	5500	620	51.1	36.2	27.0	6	966	509	60	50.7	35.7	50.7	35.7
								7	745	732	64	44.7	29.7	44.7	29.7
								8	763	667	58	57.7	42.7	57.7	42.7
								9	583	656	61	42.7	27.7	42.7	27.7
								10	721	586	68	36.7	21.7	36.7	21.7
Price's Landing	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	68	5500	620	51.1	36.2	27.0	11	904	609	61	34.7	18.7	34.7	18.7
								12	748	1355	64	26.7	11.7	26.7	11.7
								13	708		70	24.7	9.7	24.7	9.7
								1	1077	440	54	33.0	24.0	31.0	18.0
								2	1103	676	54	45.0	30.0	52.0	37.0
Price's Landing	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	68	5500	620	51.1	36.2	27.0	3	1216	416	58	48.0	34.0	28.0	11.0
								4	1088	638	67	33.0	18.0	23.0	8.0
								5	1063	628	64	43.0	28.0	45.0	30.0
								8	1116	583	52	47.0	32.0	58.0	43.0
								7	843	648	58	50.0	35.0	58.0	41.0
Price's Landing	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	68	5500	620	51.1	36.2	27.0	6	885	833	53	52.0	37.0	58.0	43.0
								9	915		58	40.0	25.0	32.0	17.0

(Continued)

TABLE 2 - (Continued)

Project	Bend Angle (Degrees)	Bend Radius (Ft)	Min Channel Width (Ft)	Water Depth Over Weir (ft)				Length (ft)	Dist. To Next Weir (ft)	Weir Angle (Deg)	Pre-Construction		Post-Construction	
				90th Percentile	Avg	10th Percentile	Max				Max Depth (Ft) (Below LWRP)	Weir Height (Ft)	Max Depth (Ft) (Below LWRP)	Weir Height (Ft)
Cape Bend	107	7600	640	47.0	32.3	23.5	59.5	17.4	1	457	30.0	15.0	28.0	11.0
Cape Rock (Upper)	81	4600	740	46.8	32.1	23.5	59.2	17.4	1	535	24.5	9.5	48.5	33.5
Cape Rock (Lower)	47	6300	800	46.8	32.1	23.5	59.2	17.4	1	559	19.1	4.1	42.1	27.1
Pisayune	78	10500	720	46.4	31.8	23.2	58.7	17.2	1	329	25.7	10.7	33.7	18.7
Fountain Bluff	98	6400	700	47.3	32.8	24.8	58.7	19.3	1	742	34.0	19.0	28.0	14.0

(Continued)

TABLE 2 - (Continued)

Project		Band Angle (Degrees)	Bend Radius (Ft)	Min Channel Width (Ft) -10 ft Contour	Water Depth Over Weir (ft)			Weir No.	Length (Ft)	Dist. To Next Weir (Ft)	Weir Angle (Deg)	Pre-Construction		Post-Construction	
					90th Percentile	Avg	10th Percentile					Max Depth (Ft) (Below LWRP)	Weir Height (Ft)	Max Depth (Ft) (Below LWRP)	Weir Height (Ft)
Red Rock	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	88	3800	840	47.9	33.5	25.7	1	994	713	68	24.0	9.0	21.0	6.0
Kaskaskia Bend	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	81	5500	600	48.5	32.4	25.0	2	658	690	62	36.1	21.1	30.1	15.1
St. Genevieve	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	52	10300	800	48.2	32.0	24.6	1	391	371	56	30.4	15.4	Not Available	Not Available
Fort Chartes	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	55	6000	600	45.0	30.9	23.8	1	564	848	61	25.4	10.4	47.0	32.0
Establishment	River: Date Completed Project Extent (River Miles) LWRP (NGVD) Nav. Problems Reported Weir Top Elevation	34	6700	940	45.0	31.0	24.0	1	834	385	68	36.2	21.2	Not Available	Not Available
								2	920	425	67	49.2	34.2	Not Available	Not Available
								3	736	570	74	42.2	27.2	Not Available	Not Available
								4	948		67	40.2	25.2	Not Available	Not Available

(Continued)

Project	Bend Angle (Degrees)	Min Channel Width (ft)	Water Depth Over Weir (ft)				Length (ft)	Dist. To Next Weir (ft)	Weir Angle (Deg)	Pre-Construction		Post-Construction	
			90th Percentile	10th Percentile	Avg	Max				Max Depth (ft) (Below LWRP)	Weir Height (ft)	Max Depth (ft) (Below LWRP)	Weir Height (ft)
Carl Baer	39	800	45.4	31.5	25.2	54.1	1	447	667	61	20.1	5.1	28.1
Bellerive	N/A	460	48.4	32.6	26.5	54.8	1	575	671	56	24.7	9.7	23.7
Mosenithin	33	11300	35.8	22.2	16.5	43.6	1	871	547	57	43.9	28.9	43.9
Victoria Bend	108	1100	52.5	37.5	25.8	63.4	1	410	1074	76	52.5	32.5	45.5

3 Bendway Weir Field

Constructed Bendway Weir Systems

Greenfield Bend: (Figure 1) Middle Mississippi, RM 3.1 – 3.9, Completed October, 1995, LWRP 278.8 ft above North Gulf Vertical Datum (NGVD)

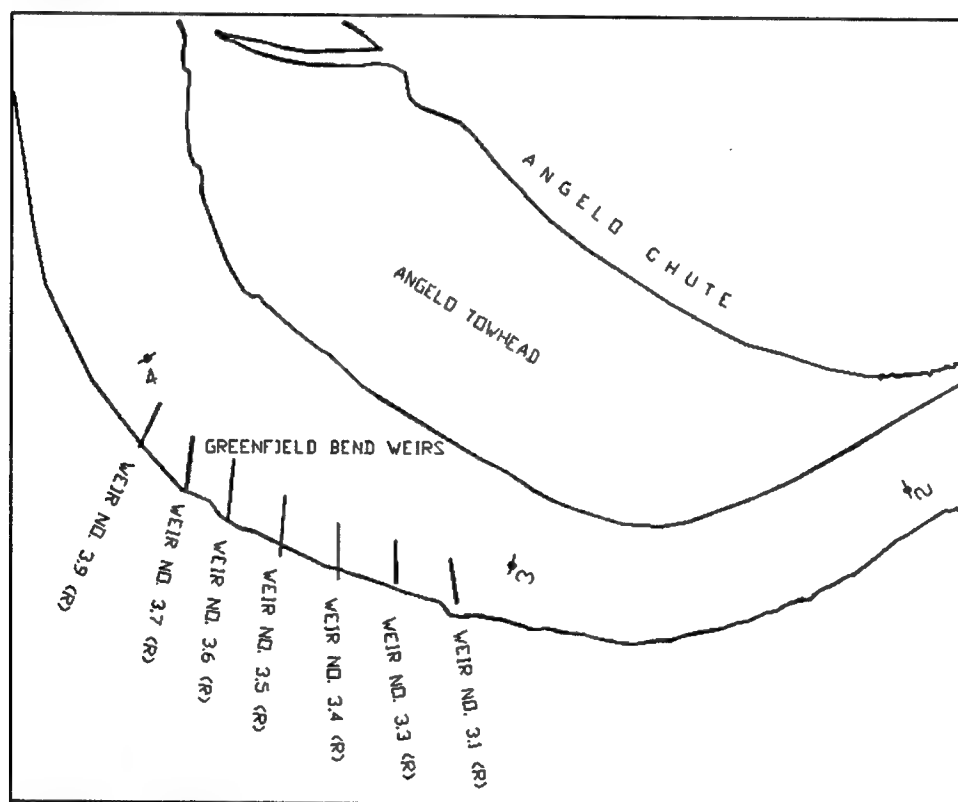


Figure 1. Greenfield Bend

The bend has an approximate angle of 71 degrees and a circular radius of 4600 ft. There are seven bendway weirs in the system with orientation angles of 64 to 76 degrees off the upstream direction. Prior to construction the minimum bottom elevation near the design weir positions ranged from 234 ft to 243 ft NGVD. With the design weir-top elevation of 263.8 ft the weirs were between 20 and 30 ft high immediately after construction. The post-construction survey shows that generally sediment deposition occurred upstream and scour downstream. Based on historical stage records the average depth over the weirs is about 37 ft with a range of 20 ft to 66 ft.

Based on pilot comments, Greenfield Bend was of the more critical areas post-construction. The general comment seemed to be that slow moving tows, i.e., heavy and upbound, tended to be pushed out toward the bar. The average pilot rating for Greenfield after weir construction indicated more difficulty than before in low flow and less difficulty during high flow. The pilot comments were as follows:

- Greenfield, I haven't caught it yet. The only thing I know is my partner told me it turned him every way it could N/B, that was 5/12/98.
- Greenfield Bend is real bad with a slow moving tow. It wants to take you out on the bar at a low flow.
- At Greenfield I noticed a hard draft on red buoy – upbound with a heavy tow barely kept buoy from going under boat. Downbound at Greenfield current was very swift and drafty. I almost overflanked one time out running red buoys and sand bars.
- N/B in low Cairo gage 15 ft or lower, there is a hard draft angle to towhead MI 3.5.

Eliza Point: (Figure 2) Middle Mississippi, RM 5.7 – 6.7, Completed December, 1995, LWRP 280.5 ft NGVD.

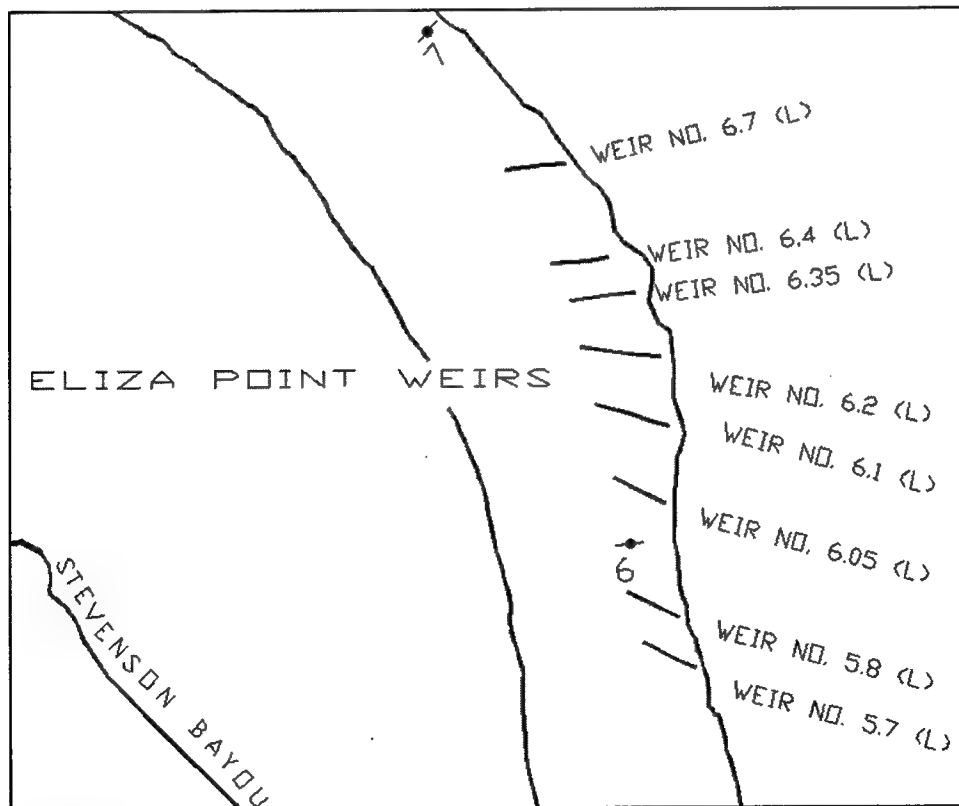


Figure 2. Eliza Point

The bend has an approximate angle of 53 degrees and a circular radius of 5300 ft. There are eight weirs in the system with orientation angles ranging from 61 to 77 degrees from the upstream direction. Prior to construction the minimum bottom elevation near the design weir positions ranged from 222 ft to 245 ft NGVD. With the design weir-top elevation of 265.5 ft the weirs were between 20 and 43 ft high immediately after construction. The post-construction survey shows that generally sediment deposition occurred downstream and scour upstream. The average depth over the weirs is about 37 ft with a range of 20 ft to 66 ft.

The average difficulty rating by the pilots was comparatively low and showed little change post-construction. No comments concerning navigation through Eliza Point bend were received.

Scudder's Landing (Figure 3) Middle Mississippi, RM 16.7 – 17.3, Completed December 1995, LWRP 286.9 ft NGVD.

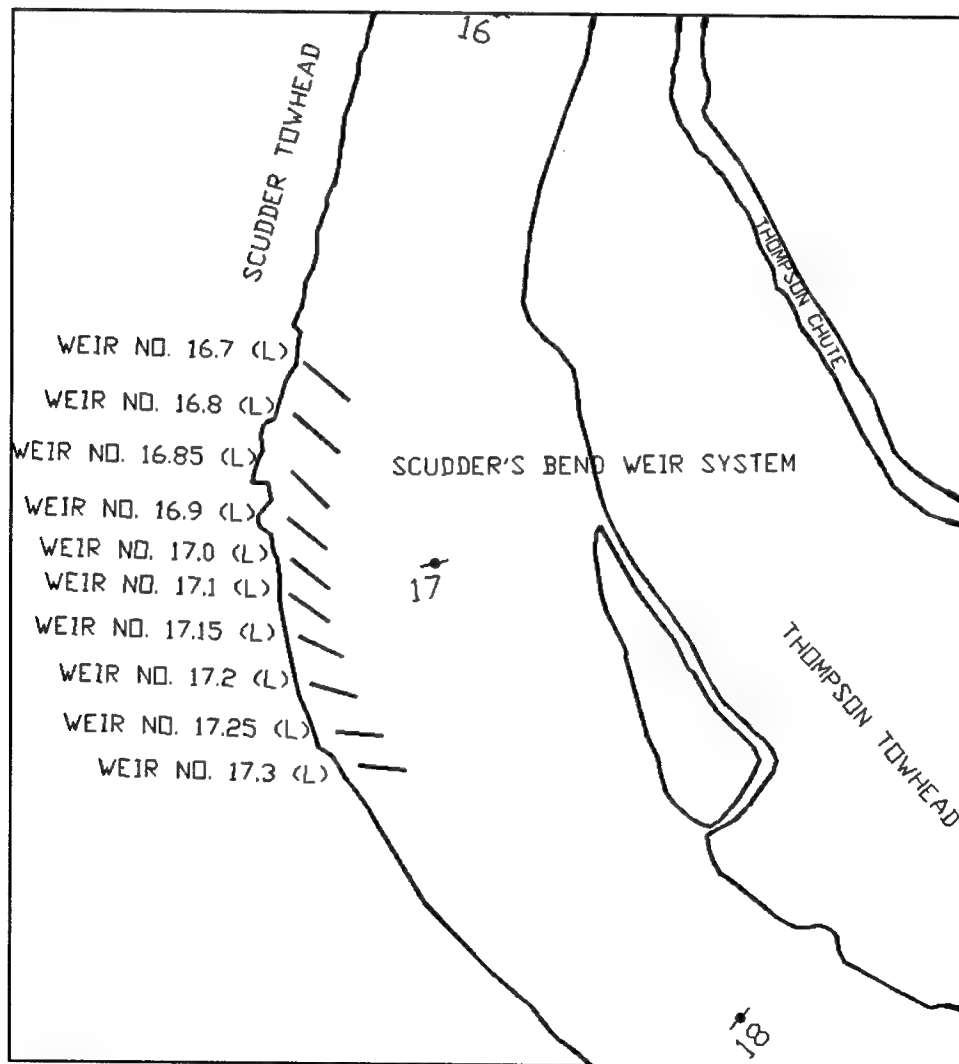


Figure 3. Scudder's Landing

The bend has an approximate angle of 76 degrees and a circular radius of 7500 ft.

There are ten weirs in the system with orientation angles ranging from 42 to 63 degrees from the upstream direction. Prior to construction the minimum bottom elevation near the design weir positions ranged from 218 to 259 ft above NGVD. Since the weir-top elevation was 271.9, the weirs were between 13 and 54 ft high right after construction. No post construction survey was available to determine post construction scour and deposition patterns. The average water depth over the weirs has been about 36 ft with a range of 20 to 65 ft.

Pilot rated difficulty shows post-construction improvement for both high and low flow; however, some disagreement was evident. Pilot comments are as follows:

- Scudders is like Fort Chartres, it grabs the head of the tow and doesn't let go, we have to steer to port to get up through it.
- Cape Rock – Price to Daniels and Scudders are much easier since construction.

Dogtooth Bend: (Figure 4) Middle Mississippi, RM 22.4 – 24.2, Completed December 1990, LWRP 290.7 ft NGVD.

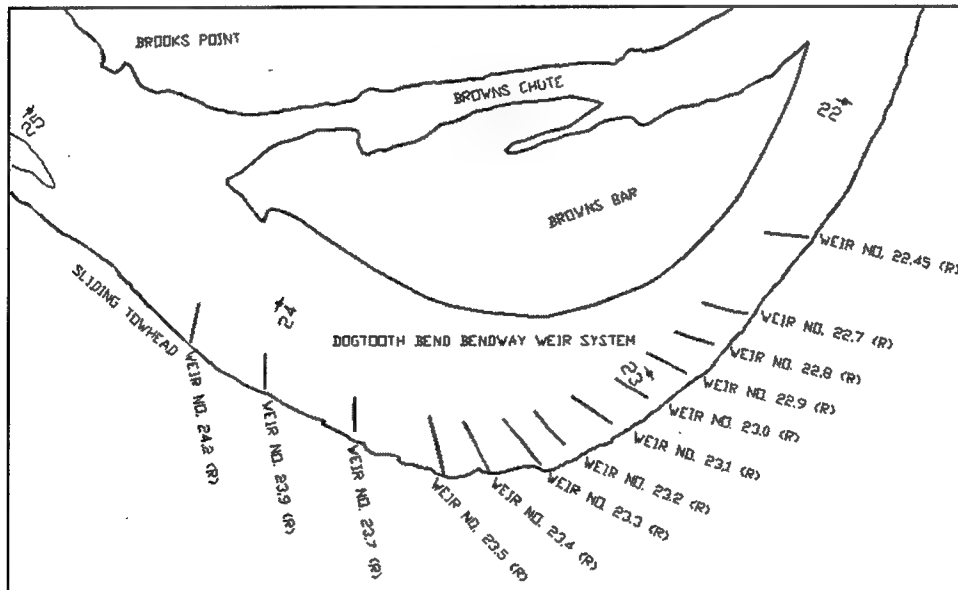


Figure 4. Dogtooth Bend

The bend has an angle of 108 degrees and a circular radius of 6400 ft. There are thirteen weirs in the system with orientation angles ranging from 57 to 75 degrees from the upstream direction. There was no pre-construction survey available; however, the post-construction survey shows that the weir heights ranged from 10 to 55 ft. The average water depth over the weirs was 36 ft and ranged from 21 to 64 ft.

Pilot ratings indicated post-construction improvement in navigation conditions for both high and low flow. Pilot comments were minimal:

- Very strong draft on bar.

Price's Landing: (Figure 5) Middle Mississippi, RM 29.6 – 30.6, Completed November 1991, LWRP 294.0 ft NGVD.

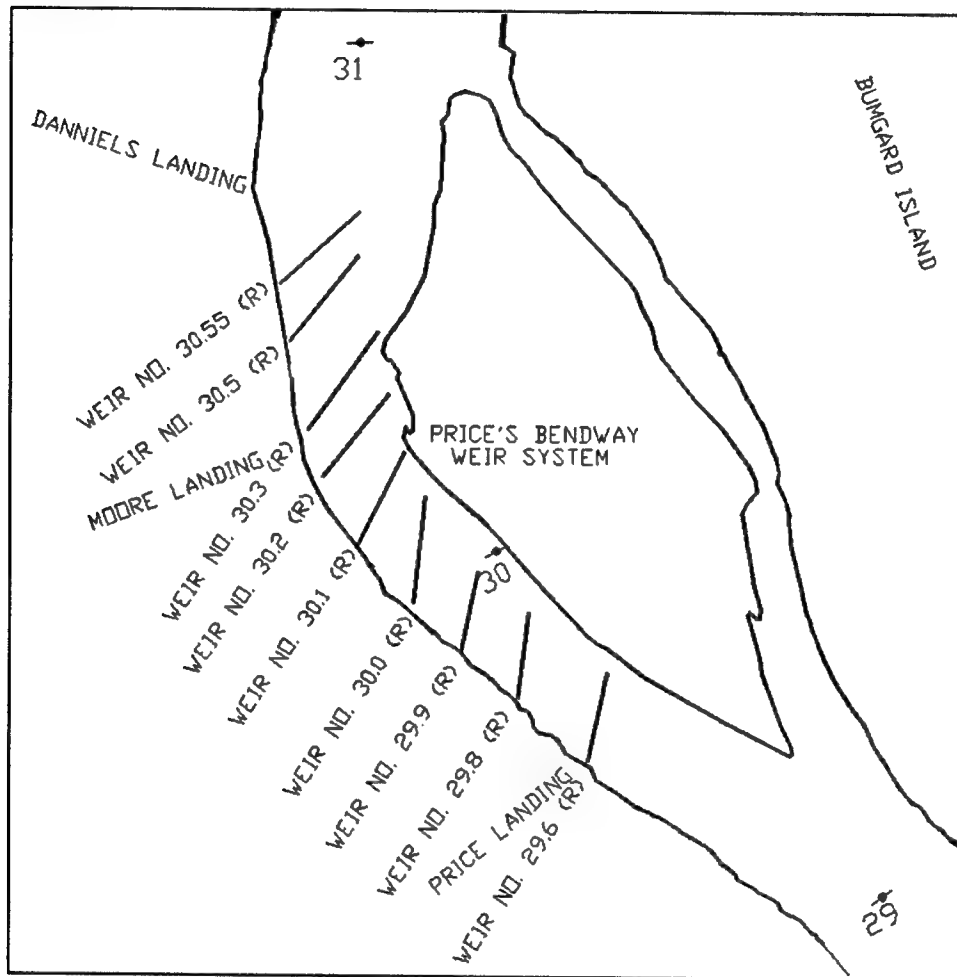


Figure 5. Price's Landing

The bend has an angle of 68 degrees and a circular radius of 5500 ft. There are nine weirs in the system oriented with the upstream direction at angles of 52 to 67 degrees. Prior to construction the minimum bottom elevation near the design weir positions ranged from 242 ft to 261 ft NGVD. With the design weir-top elevation of 279 ft the weirs were between 18 and 37 ft high immediately after construction. The post-construction survey shows that deposition occurred downstream of some of the weirs and scour below others. The average depth over the weirs is about 36 ft with a range of 21 ft to 64 ft.

Pilot ratings show less difficult tow navigation post-construction. Price's Landing was mentioned only once in the pilot comments:

- Cape Bend – Price to Daniels and Scudders are much easier since construction.

Cape Bend: (Figure 6) Middle Mississippi, RM 48.3 – 49.5, Completed March 1995, LWRP 308 ft NGVD.

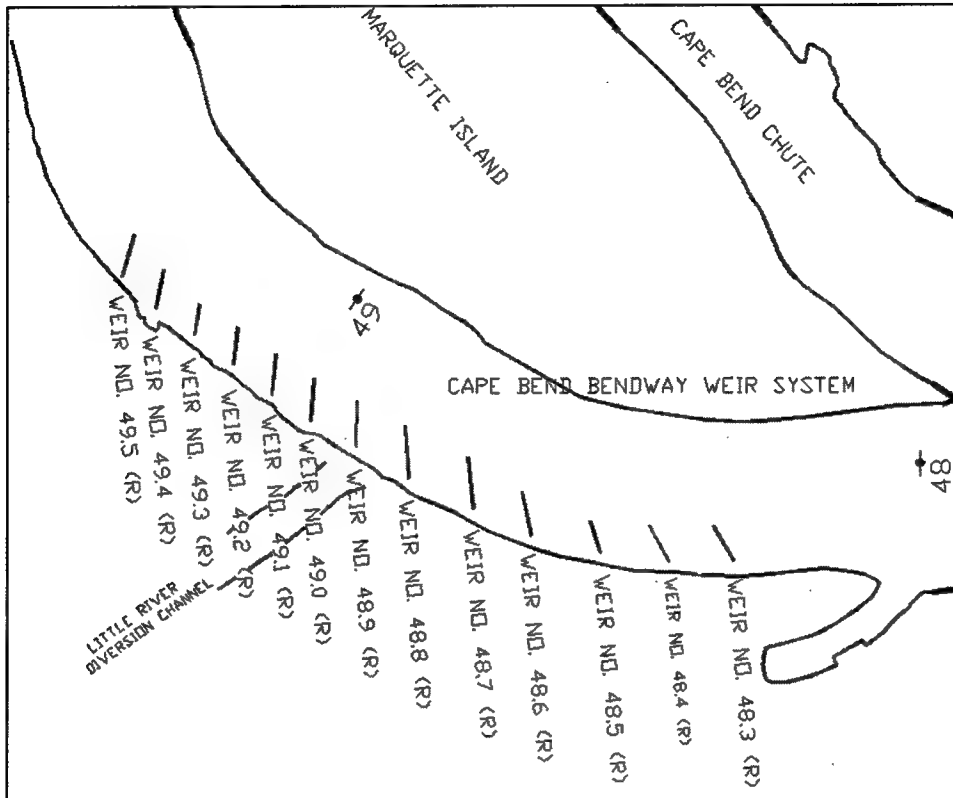


Figure 6. Cape Bend

The bend has an angle of 107 degrees and a circular radius of 7600 ft. There are thirteen weirs in the system oriented with the upstream direction at angles of 53 to 67 degrees. Prior to construction the minimum bottom elevation near the design weir positions ranged from 269 ft to 287 ft NGVD. With the design weir-top elevation of 293 ft the weirs were between 6 and 24 ft high immediately after construction. The post-construction survey shows that generally deposition occurred throughout the weir system. The average depth over the weirs is about 32 ft with a range of 17 ft to 60 ft.

Pilot ratings show less difficult tow navigation post-construction. Cape Bend was mentioned seldom in the pilot comments:

- Cape Bend – Price to Daniels and Scudders are much easier since construction.
- Cape Bend - Sometimes a little disturbance (very good).

Cape Rock: (Figure 7) Middle Mississippi, RM 53.8 – 54.9, Completed February 1992, LWRP 311.3

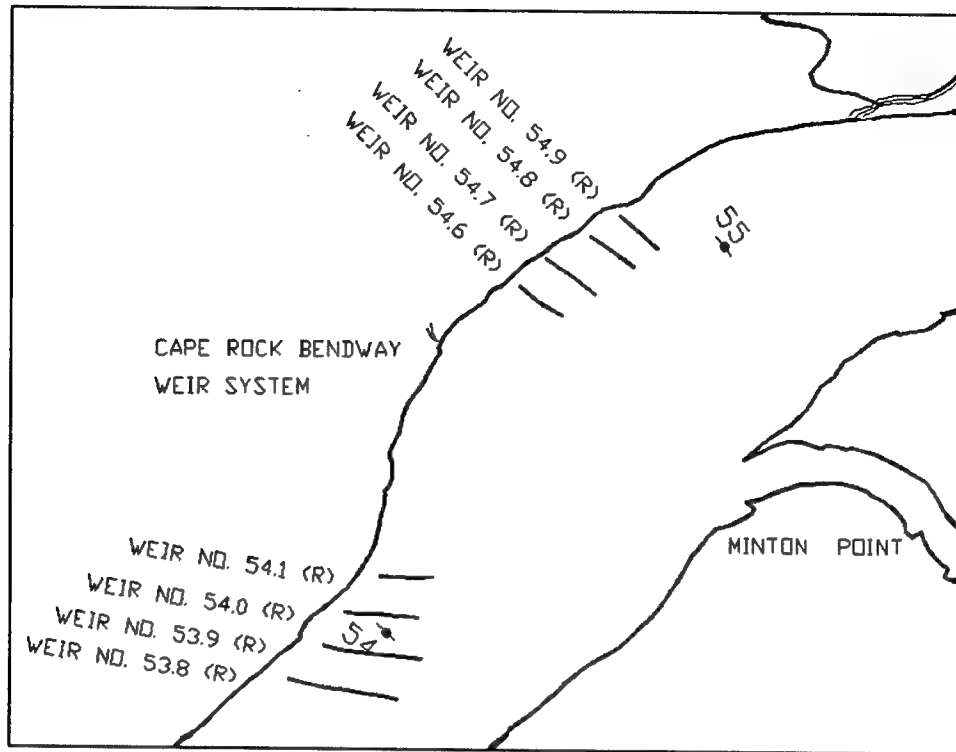


Figure 7. Cape Rock

The weir system is made up of two bends with four weirs in each. The downstream bend has an angle of 47 degrees and the upstream bend is 81 degrees. The circular radii are 6300 and 4600 ft, respectively. The pre-construction minimum bottom elevations ranged from 287 to 292 ft with weir height from 4 ft to 14 ft. The post-construction survey shows deep scour downstream of all the weirs. The average depth over the weirs is about 32 ft with a range of 17 ft to 59 ft.

Pilot ratings indicate an improvement in navigation conditions after construction of the Cape Rock weirs; however, pilot comments conflict:

- Cape Rock still has a large eddy at the foot of the bend and will affect your tow N/B and S/B at most stages.
- Cape Rock – a large eddy at the foot of bend – bad N/B and S/B.
- Cape Rock was real bad for a while but at this time in low flow it seemed somewhat better. That dike below [?] needs to have about half of it removed.

Picayune (Figure 8) Middle Mississippi, RM 55.8 – 57.8, Completed February 1995, LWRP 312.7 ft NGVD.

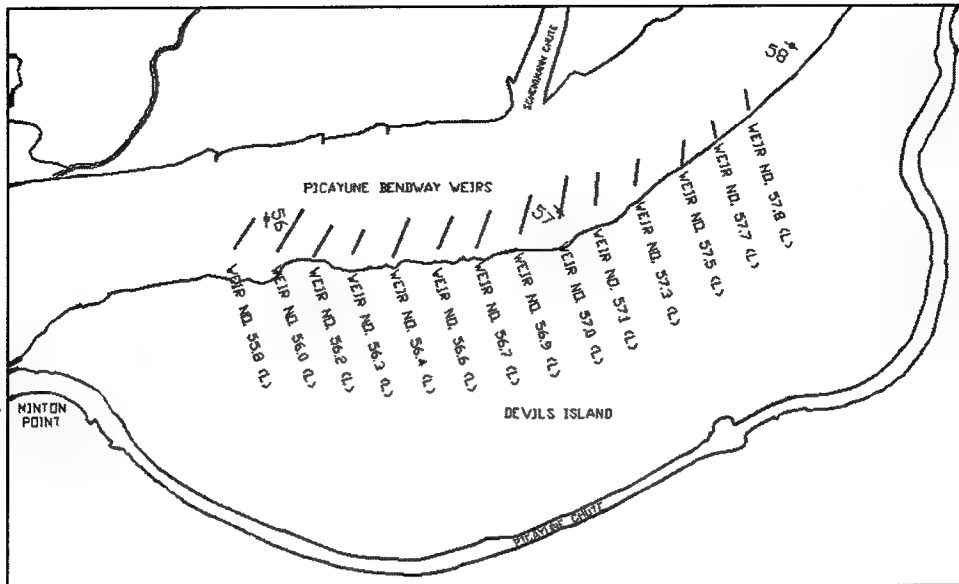


Figure 8. Picayune

The bend angle is approximately 78 degrees with a radius of 10,500 ft. There are fourteen weirs in the system with orientation angles with the upstream direction of 51 to 66 degrees. Minimum pre-construction bottom elevations ranged from 268 ft to 290 ft NGVD giving weir heights between 8 and 30 ft. Post-construction surveys show scour generally upstream and deposition downstream. The average water depth over the weirs is 32 ft with a range of 17 to 59 ft.

Pilot ratings show less difficult tow navigation post-construction. The pilots did not comment specifically on the Picayune Bend.

Fountain Bluff: (Figure 9) Middle Mississippi, RM 83 – 84.1, Completed January 1996, LWRP 326 ft NGVD

The bend angle is about 98 degrees with a radius of 6400 ft. There are ten weirs constructed and are oriented with the upstream direction at between 57 and 71 degrees. Minimum pre-construction bottom elevations ranged from 273 ft to 292 ft and the weirs were anywhere from 18 ft to 38 ft high. A post-construction survey showed some deep scour holes but overall not much change in weir height. The average water depth over the weirs is 33 ft ranging from 19 ft to 59 ft.

Pilot ratings show a general improvement in navigation conditions at Fountain Bluff post-construction. Pilot comments suggest that conditions have slowly improved:

- Fountain Bluff was bad during and several months after, but has settled down and smoothed out over the years.
- Fountain Bluff was bad during and several months after, has settled down over the years.

- Fountain Bluff was critical but has settled down now.
- Strong draft on bar.

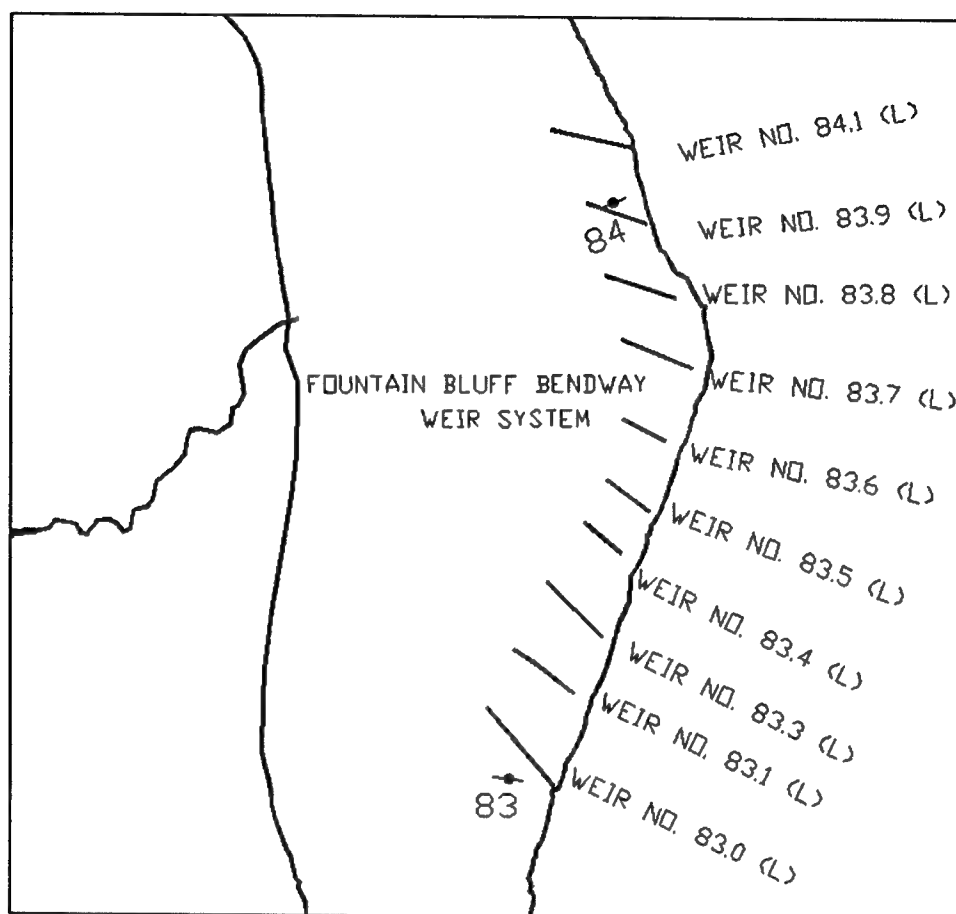


Figure 9. Fountain Bluff

Red Rock: (Figure 10) Middle Mississippi, RM 93.7 – 94.8, Completed January 1993, LWRP 331 NGVD

The bend angle is approximately 88 degrees with a radius of 4200 ft. There are nine weirs in the system, which are oriented with the upstream direction at between 63 and 75 degrees. Minimum pre-construction bottom elevations ranged from 292 ft – 307 ft and the weir heights ranged from 9 ft to 24 ft. The post-construction survey indicated a large amount of scour below all the weirs except for the first two upstream. The average water depth on the weirs is 34 ft ranging from 20 ft to 59 ft.

Pilot ratings show a significant improvement in navigation conditions at Red Rock after weir construction. No pilot comments were received for this area.

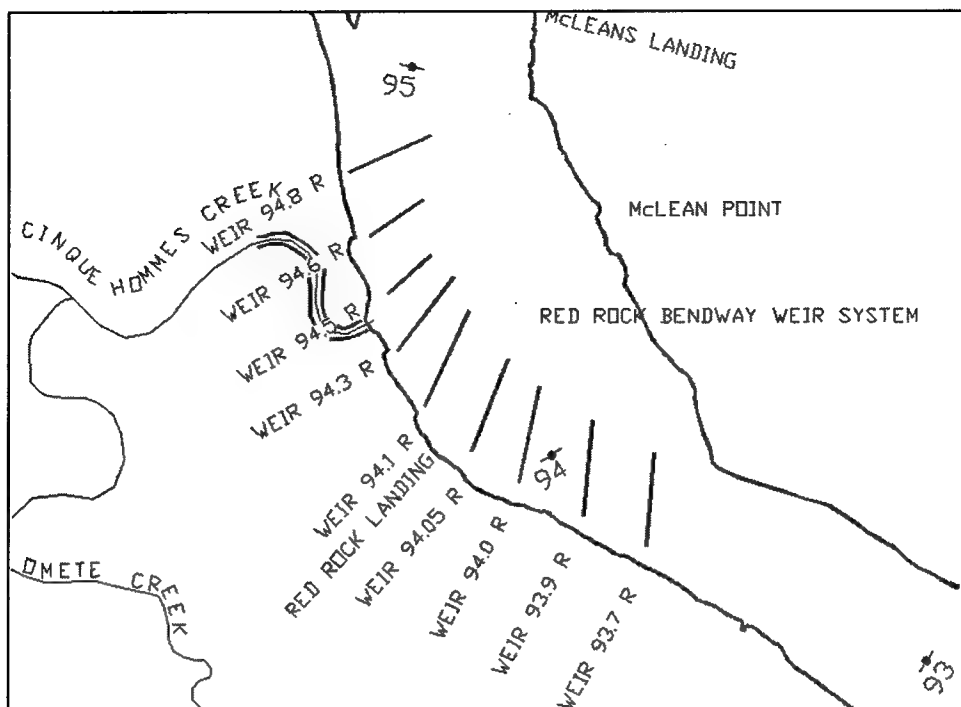


Figure 10. Red Rock

Kaskaskia Bend: (Figure 11) Middle Mississippi, RM 116.0 – 117.1, Completed March 1994, LWRP 344.1 NGVD

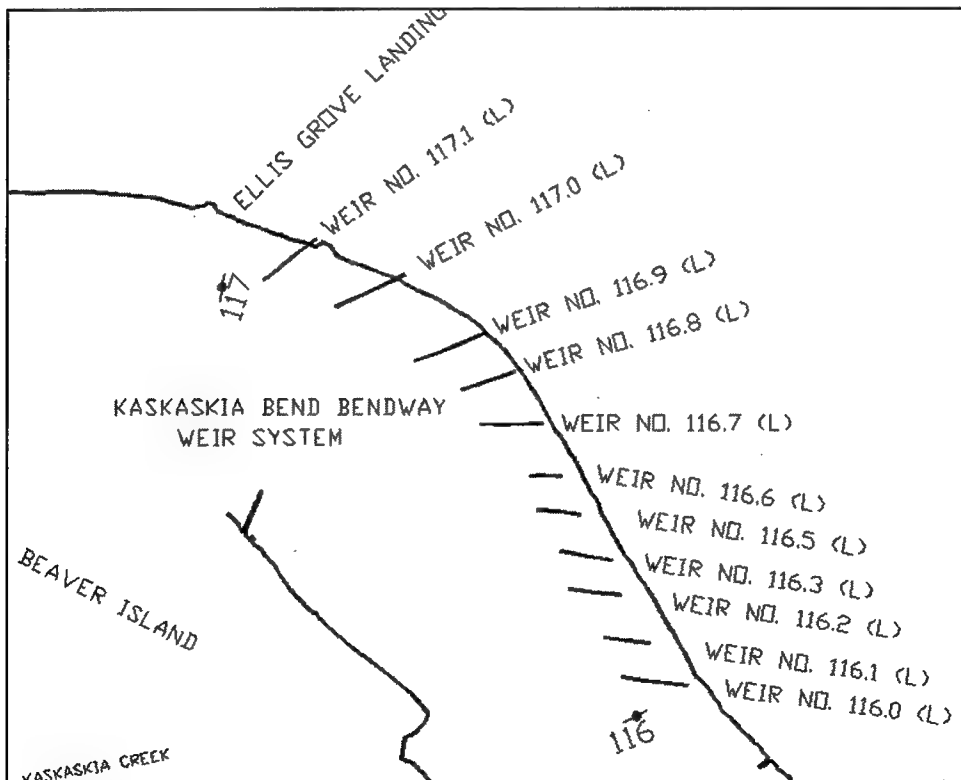


Figure 11. Kaskaskia Bend

The bend angle is approximately 81 degrees with a radius of 5500 ft. There are eleven weirs in the system which are oriented with the upstream direction at between 51 and 69 degrees. Minimum pre-construction bottom elevations ranged from 308 ft to 323 ft and the weir heights ranged from 6 ft to 21 ft. The post-construction survey generally indicated slight scour downstream of the weirs. The average water depth on the weirs is 32 ft ranging from 20 ft to 57 ft.

Pilot ratings show improvement in navigation conditions after weir construction. No pilot comments were directed specifically at Kaskaskia Bend.

St. Genevieve: (Figure 12) Middle Mississippi, RM 119.8 – 120.8, Completed September 1997, LWRP 346.4 ft NGVD.

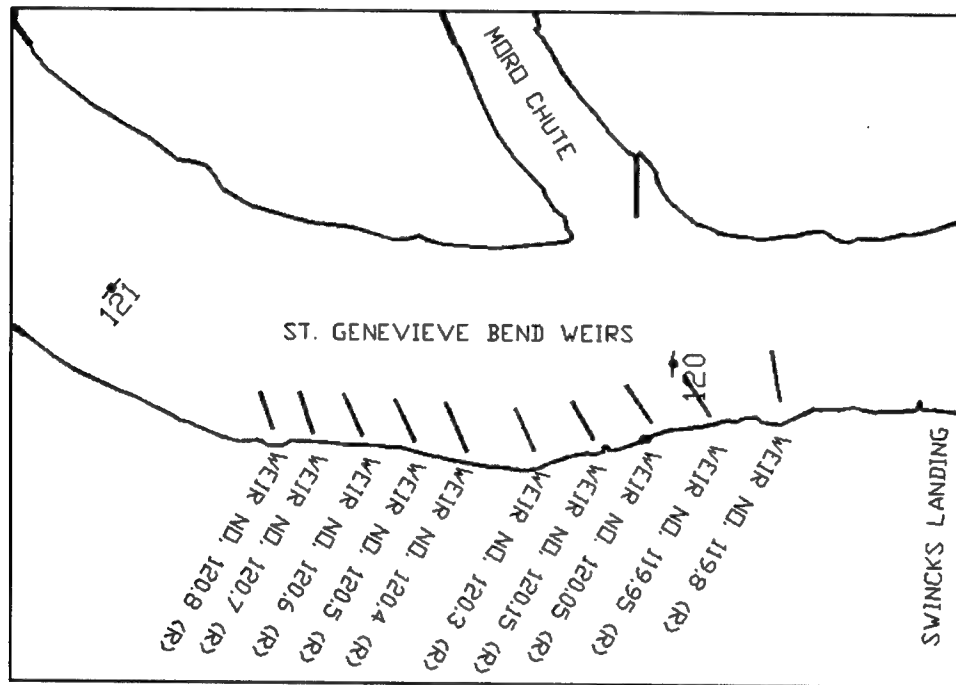


Figure 12. St. Genevieve

The bend angle is 52 degrees with a radius of 10,300 ft. There are ten weirs in the system and they are oriented with the upstream direction at between 56 and 91 degrees. Minimum pre-construction bottom elevations ranged from 314 ft to 323 ft and the weir heights were from 8 ft to 15 ft. No post-construction survey was available for comparative bottom contours. The average water depth over the weirs is 32 ft ranging from 20 ft to 56 ft.

Pilot ratings show improvement in navigation conditions after weir construction.

No pilot comments were directed at the St. Genevieve Bend.

Fort Chartres: (Figure 13) Middle Mississippi, RM 129.9 – 131.0, Completed April 1994, LWRP 353.0 ft NGVD.

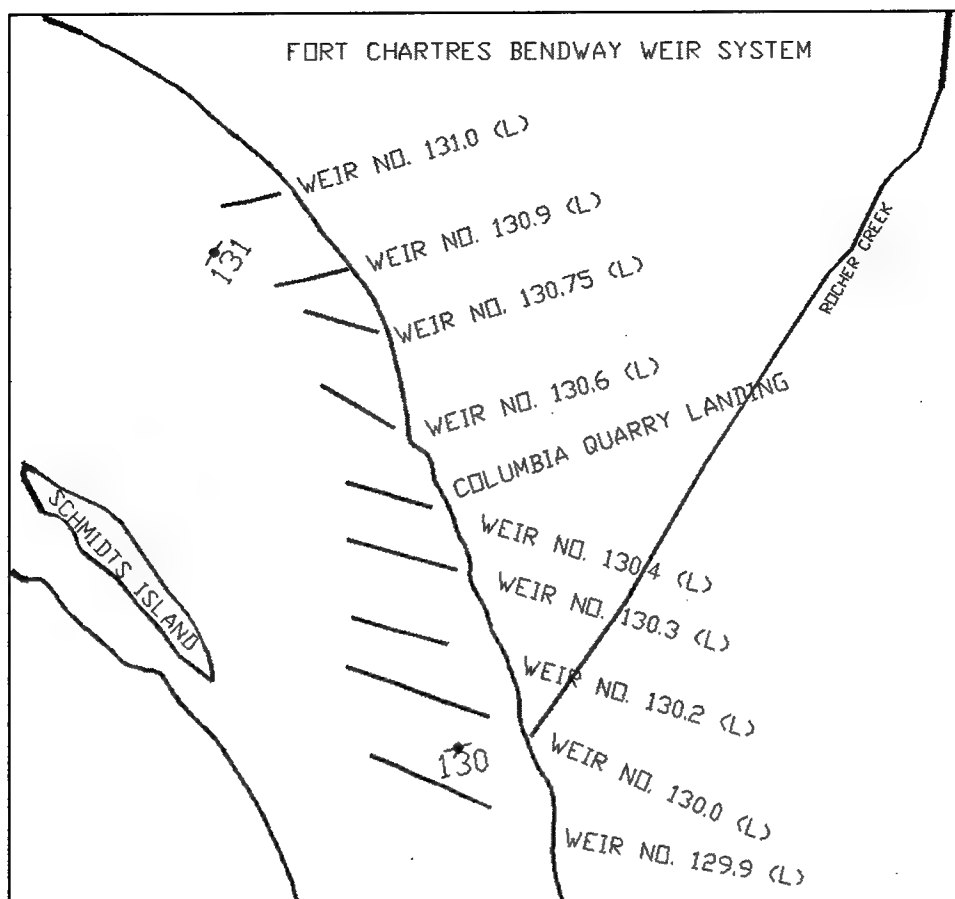


Figure 13. Fort Chartres

The bend angle is 55 degrees and the bend has a radius of 6000 ft. There are nine weirs in the system oriented with the upstream direction between 43 and 70 degrees. There was no pre-construction survey available. The post-construction survey showed significant weir heights toward the middle of the system and low weir heights at the downstream end, this pattern suggests scouring and deposition, respectively. The average water depth over the weirs is 32 ft with a range of 19 ft to 55 ft.

Pilot ratings indicate a degradation of navigation conditions post-construction. This bend is one of the more critical in the Middle Mississippi based on pilot comments:

- Fort Chartres has really been a pain in low flow north and south bound and some in high flow, it pulls the stern out and have to steer down to port to stay off the bank.
- Fort Chartres is also a place to watch real close. No matter how far you get in the bend it is going to draft you out to the bar, if moving slow it is hell handling your tow.
- Fort Chartres seems to be the worst one going N/B. Where these weirs are seems to narrow the channel above them and widen it below them.

- Personally, I like the weir dikes except the ones at Fort Chartres, if you don't watch it, it will get you N/B.
- At Fort Chartres N/B hard draft behind bar at Crooks St. Louis (Gage) 10 ft or below, S/B a little disturbance at Crooks, minor.
- Fort Chartres has had the worst reactions for me upbound – flow wasn't really [reduced]. Pushing a heavy tow N/B up into the bend can be very difficult since construction of weirs.
- The bendway weirs at Ft. Chartres create a difficult condition in low water. The water coming off the weirs is conflicting with the river flow. You have bendway weir water pushing on your starboard stern and river current pushing on your port head. At times the 2 forces easily overcome the rudder power of the vessel and make controlling the tow difficult. Similar conditions exist at Victoria Bend LM 594.
- At Fort Chartres very strong draft on bar.
- One of the most severe N/B "SETS" occurs at Fort Chartres during low water. I had a near miss at this location N/B during September 1998 with 20 loads and 4 empties on the 6200 HP Larry Y. Strain. I was favoring the center of the channel watching for the set to the buoys on the lower side of the turn. As I approached the middle of the bend (the turn buoy at the upper end of the weir field), the current coming down above the weirs caught the head of the tow causing it to swing to the left descending bank. I was steering hard down to the port and the tow was still swinging hard to the starboard. I was just about to call LEROY (cause he ain't never seen a wreck like we're fixin to have) when I finally got the swing to the bank to stop. The boat still would not swing the tow to the port with the rudders hard over to the port. The tow stalled out and started to drift back down the river – rudders still hard down to port. As it drifted back it was setting out toward the buoys where the water was slacker. It had drifted back about 1200 feet when it finally started to move ahead and steer around to the port. Looking back now, I was fortunate to have approached the bend as I did. If I had been closer to the buoys coming into the bend, the tow would have stalled and set out on the sandbar behind the buoys.

Establishment: (Figure 14) Middle Mississippi, RM 132.7 – 133.0, Completed September 1998, LWRP 354.2 ft NGVD

This weir system is located in a bend with an angle of 34 degrees and a radius of 9700 ft. There are four weirs in the system oriented with the upstream direction at 67 to 74 degrees. The pre-construction hydrographic survey shows bottom elevations ranging from 335 ft to 342 ft with weir heights from 21 ft to 34 ft. No post-construction survey was available. The average water depth over the weirs is 31 ft with a range of 19 ft to 55 ft.

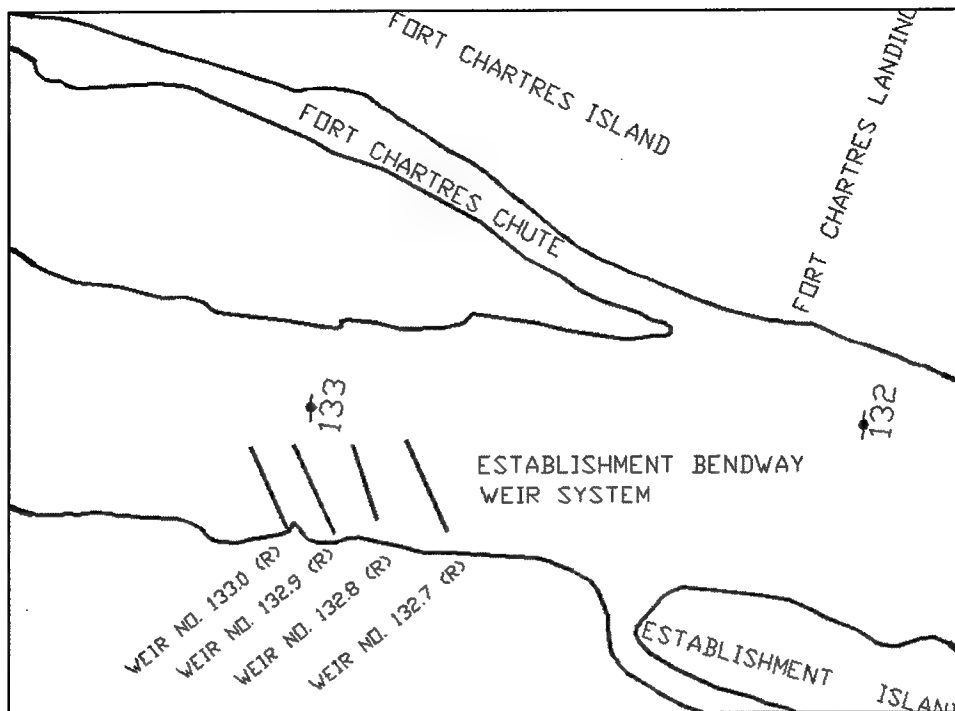


Figure 14. Establishment

Pilot comments and ratings were not collected for this bendway system. These weirs are the latest ones built and, as such, pilots have not formed an opinion yet concerning the navigation impacts.

Carl Baer: (Figure 15) Middle Mississippi, RM 163.3 – 164.0, Completed September 1996, LWRP 370.1 ft NGVD.

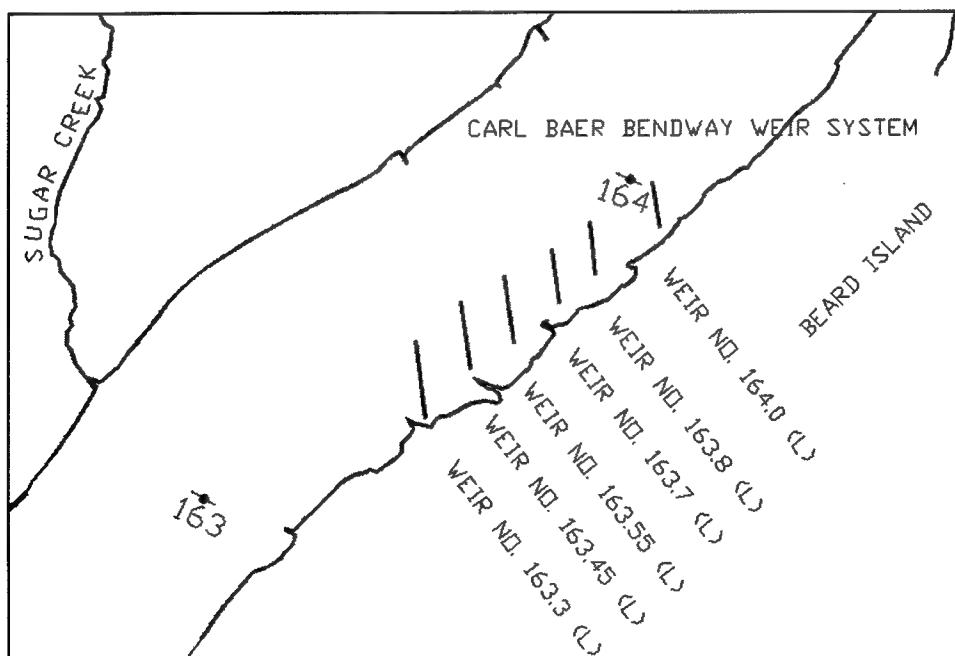


Figure 15. Carl Baer

The bend angle is approximately 39 degrees with a bend radius of 8700 ft. There are six weirs in the system oriented upstream at 61 to 78 degrees. The pre-construction hydrographic survey shows bottom elevations ranging from 325 ft to 350 ft with weir heights from 5 ft to 30 ft. The post-construction survey shows generally more deposition than scouring with weir height ranging from 7 ft to 13 ft. The average water depth over the weirs is 32 ft with a range of 21 ft to 54 ft.

Pilot ratings show an improvement in navigation conditions after weir construction. No pilot comments were received concerning navigation through this bend.

Bellerive: (Figure 16) Middle Mississippi, RM 174.0 – 174.7, Completed April 1996, LWRP 374.7 ft NGVD

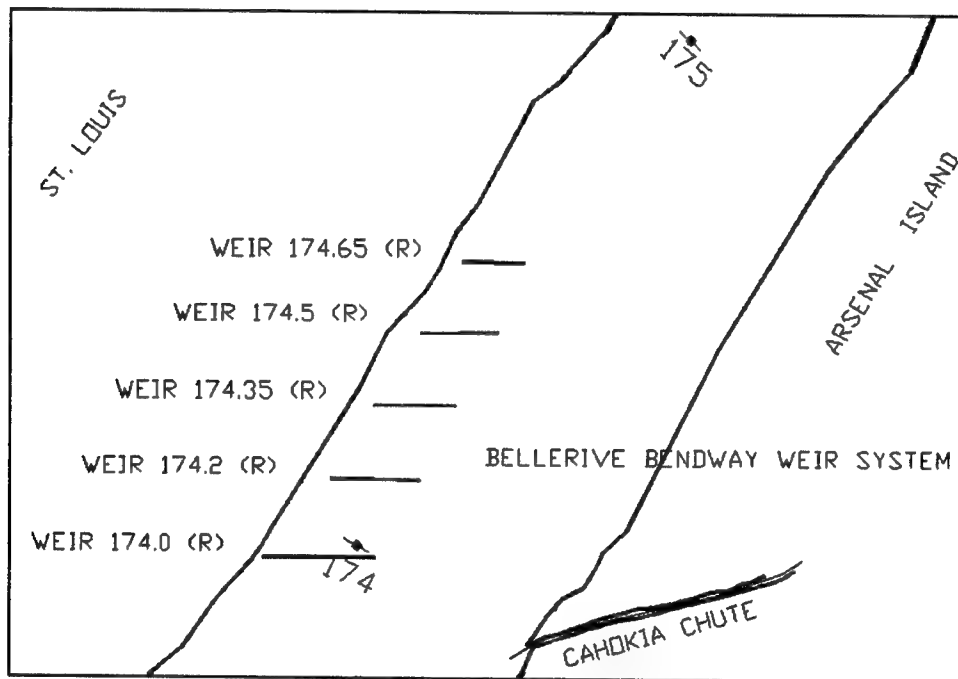


Figure 16. Bellerive

This weir system was constructed in a straight reach past St. Louis. There are five weirs in the system oriented with the upstream direction at 54 to 56 degrees. The pre-construction hydrographic survey shows bottom elevations ranging from 340 ft to 350 ft with weir heights from 8 ft to 15 ft. The post-construction survey shows generally little change in bottom conditions with some scour evident near the downstream weirs. The average water depth over the weirs is 33 ft with a range of 23 ft to 55 ft.

Pilot ratings show an improvement in navigation conditions after weir construction. No pilot comments were received concerning navigation through this reach.

Mosenthein/Chain of Rocks Canal: (Figure 17) Middle Mississippi, RM 193.9 – 195.0, Completed April 1997, LWRP 395.9 ft NGVD.

This weir system consists of six weirs split into two groups with four weirs above the mouth of the Chain of Rocks Canal and two below. The bend is gentle with a heading change of 33 degrees and a radius of 11,300 ft. The weirs are oriented with the upstream direction at 57 to 68 degrees. Only a partial pre-construction hydrographic survey was available which shows bottom elevations around 350 ft with weir heights 30 ft. The post-construction survey shows weir heights ranging from 29 to 44 ft. The average water depth over the weirs is 25 ft with a range of 18 ft to 42 ft.

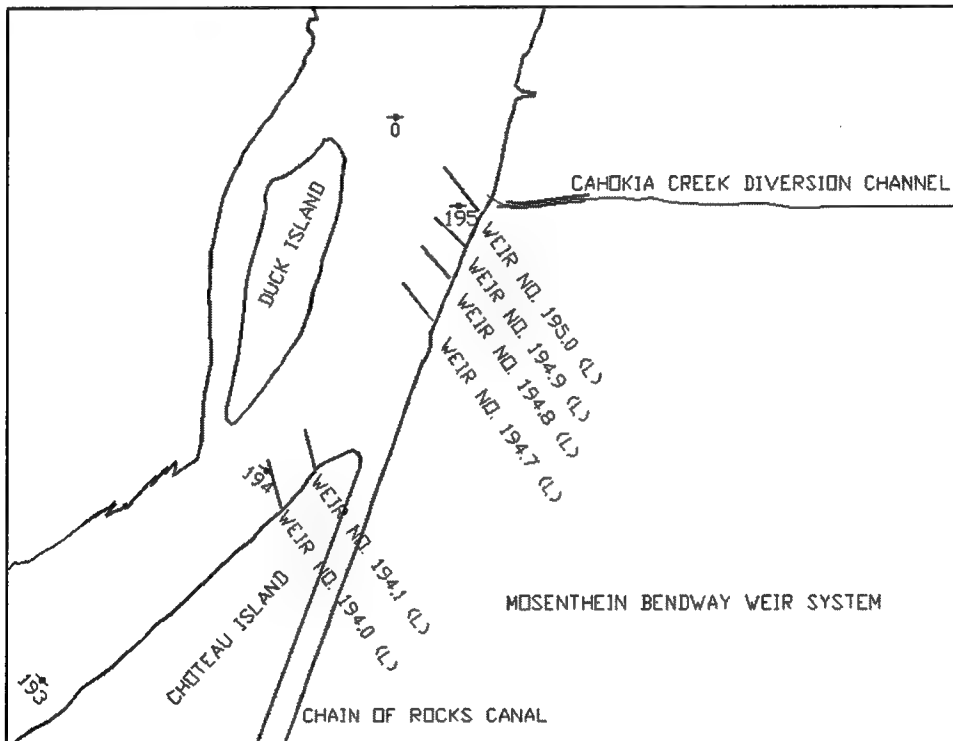


Figure 17 Mosenthein/Chain of Rocks Canal

Pilot ratings show an improvement in navigation conditions after weir construction; however, this conflicts strongly with the comments received:

- The weir above Chain of Rocks Canal is going to cause someone to sink some time. That has caused an extreme draft to the head of the island and you have to shove the left bank downbound.
- Chain of Rocks Canal. The head is becoming a nightmare. For years you try to miss Continental Oil dock, now you better try and hit it, if not you will hit the head of the island, the higher the water the worse its is.
- The Mosenthein weirs should never have been put in. Post construction causes you to hold out more off [?] dock which makes it extremely hard. To get tow back closer to shore to make it in mouth of Chain of Rocks

- The Mosenthein has made the entrance to the Chain of Rocks Canal a little more tricky than what it used to be. The draft is very hard pulling you away from the entrance the higher the flow the worse it gets.

[illegible]

This weir system consists of six weirs oriented with the upstream direction at 69 to 76 degrees. The bend has a heading change of 108 degrees and a radius of 4200 ft. The pre-construction hydrographic survey shows bottom elevations ranging from 44 ft to 60 ft with weir heights from 24 ft to 43 ft. The post-construction survey shows deposition at the upstream weir and scouring throughout the remainder of the system. The average water depth over the weirs is 37 ft with a range of 22 ft to 63 ft.

Chapter 3 Bendway Weir Field

- Victoria Bend - Tow handling is erratic S/B and N/B at all stages.
- Victoria Bend – Tow handling is erratic S/B and N/B at all stages.
- I found that all the bend weirs on the upper Miss. worked good for me.
- But at Victoria Bend, mile 594 LMR, someone goofed.
- Victoria has some bad boils and eddies in The Pocket that get real bad north and south bound at all stages.
- Victoria Bend – weirs have made lower end swifter.
- The bendway weirs at Ft. Chartres create a difficult condition in low water. The water coming off the weirs is conflicting with the river flow. You have bendway weir water pushing on your starboard stern and river current pushing on your port head. At times the 2 forces easily over come the rudder power of the vessel and make controlling the tow difficult. Similar conditions exist at Victoria Bend LM 594.
- Victoria Bend S/B Aug of 1999 a very dangerous place; flanking all the current is running behind Blacks above and below the turn, it wants to quit flanking because there dead water in bend above coming in turn and it will try to top you around on bar. Its very difficulty to flank right now (9-7-99). N/B at Victoria on turn hard drift behind Blacks as tow goes over weirs in the bend. Very stressful with N/B heavy tow.
- Victoria created strong current to bar above weirs and current to shore under them but has been a definite improvement.

4 Post Construction Analysis

Pilot General Comments

In addition to the bend-specific comments, pilot general opinions concerning bendway weirs were received:

- I found that all the bend weirs on the upper Miss. Worked good for me.
- As with anything that effects current flow, weir projects consequentially affect navigation. Each weir field has characteristics that require "GETTING USED TO" after they are installed. Almost all of the projects have a tendency to "SET OUT" on the buoys when you are N/B.
- All-in all the weir projects are a vast improvement over the previous conditions. The only problem I see with the weirs is that in most locations the weir fields do not start far enough toward the upper part of the turn. This causes the middle and lower part of the turns to be about right, but the upper part is narrow and very swift above the weirs. If you have to flank one of them S/B the tow starts out flanking normal on the upper end then stops flanking when you get into the weir field. If you are moving down the river at current speed when this happens you are fixing to "BUTT THE BANK." About all you can do to avoid this is to slow down below current speed and "jerk" the head out of the bend a little to make it start flanking again.
- In all I'm very much in favor for weir dikes. They have done a great job.
- I'm not in favor of putting weir dikes at Bird Point Elevator. It's a bad idea.
- All in all I think the weir dikes have helped navigation a great deal.
- Where even the weir dikes are N/B there is a hard draft when you are coming up under them they will set you hard on the bar the slower moving the tow the harder it sets you.

Unconstructed Bendway Weir Systems

Two other bendway weir systems are currently being designed in the Lower Mississippi River. The White River weir system is currently being planned for construction near RM 599. For this system several alternative designs have been considered but final plans have not been formalized. The second proposed weir system in the Lower Mississippi has been planned in Walker Bend above the Highway 82 Bridge near RM 532 at Greenville, Mississippi. Final design for the latter weir system has not been completed.

Analysis of Reported Accidents

The U.S. Coast Guard Marine Casualty and Pollution Investigations Database for the calendar years 1993-1997 was searched for accidents reported at the bendway weir project sites on the Mississippi River. Accidents involving allisions, collisions, and groundings of vessels that occurred within one river mile upstream and downstream of each project were identified and analyzed. Accidents caused by other factors, e.g. equipment failure, etc., were not included in the analysis. The full accident database is shown in Appendix A. A summary of the accidents that occurred within the project sites during the five-year period and following the project construction completion date is presented in Table 3. Because of various project construction dates the values in Table 3 represent different sets of conditions for accidents in each bend; however, comparisons are instructive.

Greenfield, Eliza, Scudders, Picayune, St. Genevieve, and Ft Chartres have not had any recorded accidents since the projects were completed. Dogtooth, Cape Bend, Cape Rock, Red Rock, Mosenthein, and Victoria have all had more than one accident reported - most were groundings. Many involved only small tows (4 or fewer units, e.g. 3 barges and a towboat). Those accidents involving larger tows included:

- Victoria — W.J. Barta — 5 units
- Dogtooth — M/V Harriet Ann — 18 units
- Cape Bend — M/V Arnold Sobel — 5 units
- Cape Bend — M/V Leslie B — 6 units
- Red Rock — M/B Transporter — 9 units
- Kaskaskia — Ray A Eckstein — 23 units

The details of these accidents were not investigated in depth to determine specific cause or to what extent the presence of bendway weirs created critical conditions; however, these statistics do indicate that the weir projects did not eliminate accidents. Dogtooth Bend, Cape Bend, Cape Rock, Mosenthein, and Victoria all averaged at least one accident per year following weir construction.

Mosenthein was completed less than one year during the record but a relatively large number of accidents with small tows continued to occur in the area. Pilot comments collected during this study concerning the Mosenthein/Chain of Rocks vicinity were strong and negative.

Victoria Bend in the Lower Mississippi also had a relatively short history in the accident database after weir construction (about two years) but received significant negative pilot comments – often directed at both upbound and downbound transits. It had the second highest accident rate. However, the sizes of the tows involved in the reported accidents were relatively small (2, 4 and 5 units) compared to the predominant sizes of tows which operate on the Lower Mississippi (25, 30, 35, 42, up to 49 units).

Table 3. Summary of U.S. Coast Guard Accident Data (1993-1997)

Bend	Install. Date	Accidents (after installation)										Number of	
		Grounding		Collision		Allision		Total		Total/Yr		Vessels	
		All	Post	All	Post	All	Post	All	Post	All	Post	All	Post
Greenfield	Oct-95	2						2		0.4		4	
Eliza	Dec-95												
Scudders	Dec-95	6				1		7		1.4		15	
Dogtooth	Dec-90	8	8					8	8	1.6	1.6	34	34
Price's Landing	Nov-91	1	1					1	1	0.2	0.2	2	2
Cape Bend	Mar-95	2	1	3	2			5	3	1.0	1.1	22	15
Cape Rock	Feb-92	5	5					5	5	1.0	1.0	10	10
Picayune	Feb-95	1						1		0.2		4	
Fountain Bluff	Jan-96	4	1					4	1	0.8	0.5	26	2
Red Rock	Jan-93	2	2	1	1			3	3	0.6	0.6	17	17
Kaskaskia	Mar-94	1				1	1	2	1	0.4	0.3	27	23
St. Genevieve	Sep-97												
Ft. Chartres	Apr-94												
Carl Baer	Sep-96					1	1	1	1	0.2	0.8	2	2
Bellerive	Apr-96	1	1					1	1	0.2	0.6	1	1
Mosenthein	Apr-97	12	6			2	1	14	7	2.8	10.5	34	18
Victoria	95	6	4	1				7	4	1.4	2.0	22	15

While Dogtooth, Cape Bend and Cape Rock received some negative comments, the criticisms were relatively mild compared to others and did not indicate any serious problems. There were comments about a strong draft on the bar at Dogtooth and an eddy at the foot of Cape Rock, but these only came from one or two of the pilots. However, all of these bends had a relatively high number of recorded accidents involving large tows suggesting potential design problems.

Another observation from the analysis of the accident data was that there were no accidents reported near the bend at Ft. Chartres which received many negative comments from the pilots. There was special concern about northbound traffic and currents that made controlling the tows difficult. Apparently, these critical conditions have not resulted in accidents. Other bends that received negative pilot comments, especially for northbound tows and low water conditions, were

Greenfield, Eliza, and Scudders. As with Ft. Chartres, Greenfield and Scudders received some comments about difficult currents; however, Eliza received no pilot comments at all. Greenfield and Scudders had accidents prior to weir construction but none afterward. During the entire period of record no accidents were listed for Eliza bend.

Predominantly, conclusions concerning navigation difficulties drawn from the accident record paint a different picture than conclusions drawn from pilot comments received. It is probable that during numerous critical situations over the years (such as those mentioned in pilot comments) the "chain of events" that usually occurs in accidents did not fully develop and a reportable incident did not result. In such instances evidence of control problems would show up in negative comments but not in the accident database. The converse circumstance in which pilot comments were mild but the accident count was fairly high (Dogtooth, Cape Bend, Cape Rock) is more difficult to account for; however, it is highly unlikely that the pilots surveyed during the present study were the same ones involved in the reported accidents. Currently, a new reporting system is being initiated that will allow the anonymous reporting of incidents that might provide a better indication of navigation difficulties. The fact that several incidents are reported in the pilots' comments is an indication that the proposed system will be helpful in identifying channel reaches that should be considered for corrective action.

Summary of Survey Results

Each bendway weir project reach was unique and it is difficult to generalize the results of the characteristics. The radius of the bends involved ranged from 4,200 ft to 11,300 ft. The minimum width of the channel after construction ranged from 340 ft to 1,140 ft. The bend angle varied from 33 to 108 degrees. The degree of curvature ranged from 0.51 to 1.36 degrees per ft of arc.

In all of the Upper Mississippi River projects the design height of the weirs was set to -15 ft LWRP, while the only project in the Lower Mississippi River is set to -20 ft LWRP. The number of weirs in a project varied from 4 to 13. Many of the weir systems start deep into the bend relative to the upstream end. The length of the weirs varied from 296 to 1,420 ft with most being 400-700 ft long. The angle of the weirs to the curve tangent was normally between 50 to 75 degrees, ranging from a minimum of 42 to a maximum of 91 degrees. Generally the angles of the weirs were relatively uniform; however, in at least two cases there were unusual combinations of weir angles in the upper reaches of Ft. Chartres and Victoria bends. The minimum depth of water over the weirs ranged from 17.2 to 22.7 ft with the average being about 20 ft. The maximum water depth over the weirs was 66.3 ft. The maximum post-construction depth downstream of the weirs ranged from 16 ft to 85 ft while the nominal weir height post-construction ranged from 0 to 65.5 ft. Generally the weir fields tended to fill in behind the upstream weirs.

Post-construction current patterns were available only for Victoria Bend. These data showed an increase in current magnitude in the navigation channel, more uniformly distributed throughout the channel width. In direction, the

currents tended to be more uniform along the length of the channel post-construction. Because of this, the currents on the inside of the bend, i.e. along the point bar where the upbound tows tend to transit, are increased, sometimes significantly.

Navigation Changes due to Bendways

Based on the pilots' survey comments and rating sheets, some general trends can be observed in the changes that the weirs made to navigation conditions. Generally speaking, all pilots agreed that the weirs improved navigation conditions for downbound tows. Some comments, received in conversations with port captains, indicated that most projects cause some difficulties immediately after construction on the point bar because currents are increased due to the restricted channel area. The consensus in the towing industry is that for many of the bendway weir systems the channel continues to develop during the post-construction period and navigation difficulties tend to lessen. The survey ratings indicated that most projects showed improvements in the navigation conditions for southbound tows except at Victoria and Cape Rock (under high flow) Bends. Red Rock was rated as having exceptional improvements in both north and southbound directions for both high and low flow conditions. Carl Baer was rated as having been improved in low flow conditions for both upbound and downbound traffic. Scudders was rated as having significant improvements for southbound transits under all flow conditions and Bellerive was rated as having significantly improved overall.

With few exceptions, all projects were indicated to have caused decreased tow speeds upbound over the weirs; due probably to increased current magnitude closer to the point bar where the northbound traffic transits. Greenfield was noted to have the largest decrease in speed, especially during low flows. The majority of pilots indicated erratic control due to turbulent flows for Dogtooth, Ft. Chartres, and Victoria Bends for medium and low flow conditions. More than half of those responding indicated that no erratic control problems occurred for northbound traffic.

Another indication of the improved navigation conditions for southbound traffic was the reduction in flanking required. In all cases and flow conditions, flanking use remained constant or decreased. This was particularly true for low flow conditions at Greenfield, Cape Rock, Fountain Bluff, Red Rock, and Ft. Chartres.

5 Test Plan Development

Considerations for Developing Test Plan

Only two bendway weir projects have received testing for navigation conditions using detailed current measurements and remote-controlled towboats. These are the approaches to the Greenville Bridge and the upstream approach to Montgomery Point Lock and Dam. Neither of these projects has been constructed yet and there is no prototype experience with these projects. However, in both model studies, unfavorable conditions were observed and corrected to some degree.

The initial designs for the Greenville Bridge bendway weir system were developed in a moveable bed model using 25-barge tows. In these design the model weirs were constructed to make the channel widen and push back the point bar from the outside of the bend. These designs were shown in the model to greatly improve the current patterns through the critical turn; however, because the last two weirs continued to be angled upstream and to direct the currents across the channel toward the left downstream bank, the currents tended to force downbound tows to the wrong side of the channel and increased the difficulty of the bridge approach. Changing the angles of these weirs to nearly 90 degrees to the flow corrected the problem. Upbound tows experienced stronger, more erratic currents, decreased tow speed and some control problems, especially when they transited near the end of the weirs on the inside of the bend. If the tows maneuvered so that they transited in the middle of the weirs, they experienced smoother flows and less erratic behavior of the head of the tow. However, the current continued to be stronger than before the weirs were introduced to the navigation channel.

The design tow for the Montgomery Point Lock and Dam project was a 6-barge tow. In the bend just upstream from the approach to the lock and dam, bendway weirs were introduced to improve navigation conditions through the bend and to assist in aligning for the lock and open-pass approach. During testing of the initial design, it was found that the spacing of the weirs was too wide and the tow length for an upbound tow would fit between weirs, i.e. the tow could be in a position where it was in the weir field but would not be over any individual weir. This caused the current pattern to be erratic and caused erratic behavior of upbound tows, creating control problems. This was serious enough that additional weirs were installed so that the tow would be over at least two weirs at all times.

This improved the navigation conditions greatly. In this project the depth of the channel was relatively shallow and the height of the weirs was not great.

Significant Factors for the Test Plan

The factors that must be considered for developing a bendway weir test plan that will provide guidance for design criteria include:

1. Bendway geometry
 - a. Radius of the turn,
 - b. Width of channel (at least the minimum width),
 - c. Angle of the bend
 - d. The shape of the channel cross-section, including the maximum depth of the channel bed.
2. Weir design factors
 - a. Weir crest elevation relative to the low flow conditions
 - b. Angle of the weir to the flow or tangent of the bend arc
 - c. Uniformity of the weir angles
 - d. Weir spacing
 - e. Starting point of the weir field relative to bend
 - f. Number of weirs.
3. Flow conditions
 - a. Varying the discharge
 - b. Varying the tail water
 - c. Varying slope of the water surface (however, the water surface slope will generally be determined by the roughness of the channel, including the weir field and will not be controllable to a large extent).
4. Traffic considerations.
 - a. Tow size (length and width),
 - b. Tow travel direction,
 - c. Position of the tow while transiting the weir field, and
 - d. Whether two-way traffic must be maintained or if the design can allow one-way traffic.

A range of tow sizes in the same channel geometry and weir field layout must be tested as there is some evidence from the accident data and previous model tests that small tows may have more difficulty in a given weir field than larger, more typical design tows.

There are other factors that probably should be considered but, due to limitations in the research project resources, cannot be included. In the development of design criteria for bends, it was found that the distance between bends, i.e. the length of the crossing, influenced the channel width requirements. In one case, Cape Rock, two bends were designed as one bendway weir project and the angles of the weirs developed as if there was only one bend when in fact there were two bends with a very short crossing between them. The other factor found in the projects that have been built that is unusual involves a channel split that occurs in the bend. Mosenthein represents this condition where the Chain of Rocks Canal exits on the outside of the bend and the flow continues in the main part of the channel where the bendway weirs are located. Since this is special project consideration and should probably not be considered in developing general design criteria, this factor will not be considered in development of a test plan.

Testing Environment, Scale, and Time of Operations

The research program for developing the navigation design guidance for bendway weir projects has been established and initiated. There are three years to perform the test program and \$575,000 available for measurements, analysis, and reporting. A test flume has been dedicated to this testing which has dimensions 200ft x 75ft x 2ft with reversible flow up to 20 cubic feet per second (cfs). The test channels will be constructed in packed sand with generic weirs, probably made of tin or aluminum for easy installation and removal. Generally, major changes in channel geometry will require several weeks and will cost approximately \$20,000 to execute. Major changes will involve significant movement of sand and will occur when channel widths and radii are changed. Changes in degree of the bend will also require significant construction efforts but may not require the same level of effort that changing the radii and width will require as only a portion of the channel must be modified and the sand will basically be moved from one side of the channel to the other. It is estimated that a change in degree of bend could cost \$10,000.

Minor changes will be required to change the weir field layout. This will primarily be accomplished by inserting pre-constructed weir plates at particular angles. Time and cost can be reduced by starting the tests with wide weir spacing in the downstream end of the bend. The weirs can then be added to the upper portion of the bend to determine the impact of extending the weirs upstream into the bend approach channel. As a next step, weirs can be inserted between the widely spaced weirs to determine the impact of weir spacing. After a series of tests for a specific bend geometry and weir angle design, the weirs can be pulled out and reset for different angles with a repeat of the pattern for installing the weirs. At some point, a mixture of weir angles should be tested. It is estimated that it should only take a day or two to make these types of adjustments in the weir fields being tested. These operations will probably require approximately \$15,000 per change in weir angles.

Once a channel geometry and weir field is established in the model, various tow sizes, directions of travel and track paths can be tested for different flows and water depths over the weirs. These transits and the resulting current patterns will be recorded using the overhead video tracking system. Estimating approximately 5 runs/hr, a complete set of measurements for one weir angle will require approximately 5 weeks and \$11,000.

Based on this analysis of resources and the effort required to perform the necessary model tests and the analysis of the existing bends described above, it was determined that only a limited test program can be undertaken; that is, the large number of factors that need to be systematically tested and the resulting combinations of test sets will require more time and funds than are available. Therefore, it is recommended that a limited set of conditions be tested and that the tests focus on determining which factors are most significant in determining safe navigation conditions as early in the testing program as possible. In order to accomplish this, the test program must focus on only a few channel geometries and do as much as possible in varying the layout of the weir fields and tow sizes and transit paths. The tests should focus primarily on upbound transits and a range of tow sizes, including relatively small tows.

It is proposed for the first and second year of the research work \$36,000 and \$46,000, respectively, be set aside for project management and analysis of the results, and approximately \$93,000 be set aside during the final year for management, analysis and reporting. The remainder of the yearly funds will be \$164,000, \$154,000 and \$82,000, respectively, to pay for the proposed model testing program. The proposed testing program will be limited to eight sets of conditions for bend geometry consisting of combinations of two bend radii (4000 ft, 8000 ft), two channel widths (500 ft, 900 ft), and three degrees of bend (110 deg, 75 deg, 60 deg). For each of the eight geometric test conditions, the proposed test program will consist of combinations of three weir angles (45 deg, 60 deg, 75 deg), two flow conditions, three track paths and 3 tow sizes (4, 15, 30) transiting upstream and downstream with either 5, 10 or 20 weirs placed in the bend. The three track paths will be along the outside and inside of the weir system and through the middle. Downbound runs will follow a track path on the outside of the bend only. The 75-deg bend angle will be tested in the 4000-ft radius bend to give some additional information concerning the impact of the degree-of-bend.

TABLE 4 – Model Testing Program Cost

		Estimated Cost						
		Model Costs					Management	Annual
Year	R/W/Deg	Construct	Modify Weirs	Testing	Total	Cumulative	& Analysis	Budget
1	4000/500/110	20	15	11	46	46		
1	4000/500/75	10	15	11	36	82		
1	4000/500/60	10	15	11	36	118		
1	8000/500/110	20	15	11	46	164	36	200
2	8000/500/60	10	15	11	36	200		
2	4000/900/110	20	15	11	46	246		
2	4000/900/75	10	15	11	36	282		
2	4000/900/60	10	15	11	36	318	46	200
3	8000/900/110	20	15	11	46	364		
3	8000/900/60	10	15	11	36	400	93	175

The proposed test channel width of 900 ft is intended to represent a typical bend in a large river system such as the Lower Mississippi. The 500-ft channel width is intended to represent a bend in a relatively smaller river such as the Middle Mississippi or possibly another waterway such as the Red River for which bendway weir systems may be proposed and built in the future. Because of the different focus of these channel width the proposed high and low flow rates to be tested will be different. For the 900-ft channel the test flow rates proposed are based on the January 1995 through December 1998 discharge record from the recording gauge at Arkansas City, Arkansas. The proposed flow rates for this case are based on the cumulative discharge distribution where the 10th percentile (low flow) was 288,000 cfs and the 90th percentile (high flow) was 1,050,000 cfs. For the 500-ft channel the test flow rates proposed are based on the January 1990 through September 1998 discharge record from Thebes, Illinois. The proposed rates for this case were also based on the cumulative discharge distribution with the 10th percentile discharge of 125,000 cfs (low flow) and the 90th percentile of 492,000 cfs (high flow).

Proposed Physical Model Test Plan

The recommended test plan for the first year is as follows:

1. Construct a 500-ft wide channel with a bend of 4000 ft and a deflection angle of 110 degrees. (20K)
 - 1.1. Place 5 weirs equally spaced in the downstream half of the bend angled with the upstream direction at 45 degrees. (5K)
 - 1.1.1. Conduct 5 runs for each set of conditions made up of combinations of three tow sizes, two flows, two directions and three track paths.
The downbound tests will be limited to a track path along the

outside of the bend. (total 120 runs at 5 runs/hr at \$50/hr for technician – 1.2K)

- 1.2. Add 5 more weirs equally spaced filling out the upstream half of the bend.

1.2.1.Repeat 1.1.1 (1.2K)

- 1.3. Place additional weirs midway between in-place weirs. Place an additional weir at downstream end to total 20.

1.3.1.Repeat 1.1.1 (1.2K)

- 1.4. Repeat 1.1 through 1.3 with weirs angled at 60 degrees. (8.6K)

- 1.5. Repeat 1.1 through 1.3 with weirs angled at 75 degrees. (8.6K)

2. Modify model to change the bend deflection angle to 75 degrees (10K)

2.1. Repeat 1.1 through 1.5 (25.8K)

3. Modify model to change bend deflection angle to 60 degrees (10K)

3.1. Repeat 1.1 through 1.5 (25.8K)

4. Construct a 500-ft wide channel with a bend of 8000 ft and a deflection angle of 110 degrees (20K)

4.1. Repeat 1.1 through 1.5 (25.8K)

The recommended test plan continuation for the second year is as follows:

1. Modify model to change the bend deflection angle to 60 degrees (10K)

1.1. Repeat 1.1 through 1.5 from first year plan (25.8K)

2. Construct a 900-ft channel with a bend radius of 4000 ft and a bend deflection angle of 110 degrees. (20K)

2.1. Repeat 1.1 through 1.5 from first year plan (25.8K)

3. Modify model to change bend deflection angle to 75 degrees (10K)

3.1. Repeat 1.1 through 1.5 from first year plan (25.8K)

4. Modify model to change bend deflection angle to 60 degrees (10K)

4.1. Repeat 1.1 through 1.5 from first year plan (25.8K)

The recommended test plan continuation for the third year is as follows:

1. Construct a 900-ft channel with a bend radius of 8000 ft and a bend deflection angle of 110 degrees (20K)
 - 1.1. Repeat 1.1 through 1.5 from first year plan (25.8K)
2. Modify model to change bend deflection angle to 60 degrees (10K)
 - 2.1. Repeat 1.1 through 1.5 from first year plan (25.8K)

Appendix A

U.S. Coast Guard Casualty Data (1993 – 1997)

U.S. Coast Guard Casualty Data (1993-1997)											
Bandway Weir	Case	Date	Description	Waterway	Mile	Incident Type	Damage	Ves	Vessel Name	Speed	Damage Location
	MC93010781	16-Jun-93	2145 GENE NEAL, BREAKAWAY/GROUNDING	LOWER MISSISSIPPI RIVER	571	GROUNDING	\$8,000.00	5	MM-72	6	STARBOARD MIDSHIP HALF LENGTH
	MC93010718	18-Jun-93	2145 GENE NEAL, BREAKAWAY/GROUNDING	LOWER MISSISSIPPI RIVER	571	GROUNDING	\$8,000.00	5	MM-70		PORT BOW
	MC95014781	14-Sep-95	30 MV STEVE T	LOWER MISSISSIPPI RIVER	585	COLLISION	\$0.00	2	RW 251		PORT BOW
	MC94005736	21-Mar-94	2245 MV SUSAN K & MV MR. TOM	LOWER MISSISSIPPI RIVER	585	COLLISION	\$33,900.00	5	ITC 120		STARBOARD QUARTER
	MC94005736	21-Mar-94	2245 MV SUSAN K & MV MR. TOM	LOWER MISSISSIPPI RIVER	585	COLLISION	\$33,900.00	5	BUNGE 117		STARBOARD QUARTER
	MC97005443	31-Mar-97	840 MV JO ANNE STEGBAUER	LOWER MISSISSIPPI RIVER	586	GROUNDING	not noted	2	JO ANNE STEGBAUER		PORT BOW
	MC96002790	18-Feb-96	1730 AARON G COLLISION	LOWER MISSISSIPPI RIVER	586	COLLISION	not noted	2	RUBY LOUISE		NOT NOTED
	MC93020528	10-Nov-93	830 MV ANDREW CARGILL MACMILLAN	LOWER MISSISSIPPI RIVER	590	GROUNDING	\$50,000.00	6	XL 268		PORT BOW
	MC93020528	10-Nov-93	830 MV ANDREW CARGILL MACMILLAN	LOWER MISSISSIPPI RIVER	590	GROUNDING	\$50,000.00	6	XL 257		PORT BOW
	MC93020528	10-Nov-93	830 MV ANDREW CARGILL MACMILLAN	LOWER MISSISSIPPI RIVER	590	GROUNDING	\$50,000.00	6	XL 132		PORT BOW
	MC93020528	10-Nov-93	830 MV ANDREW CARGILL MACMILLAN	LOWER MISSISSIPPI RIVER	590	GROUNDING	\$50,000.00	6	XL 132		PORT BOW
	MC95003324	23-Feb-95	2342 MV ROBERT N. STOUT	LOWER MISSISSIPPI RIVER	591	EQUIP FAIL	\$20,000.00	2	MF 91		STARBOARD QUARTER
Victoria	MC97014605	2-Oct-97	150 MV OLINDA-C	LOWER MISSISSIPPI RIVER	594	GROUNDING	\$8,500.00	2	OC 374		STARBOARD BOW
Victoria	MC95004074	10-Mar-95	330 MV RANDY ECKSTEIN	LOWER MISSISSIPPI RIVER	594	GROUNDING	\$1,500.00	4	AGS 703		NOT NOTED
Victoria	MC95014236	10-Mar-95	330 MV RANDY ECKSTEIN	LOWER MISSISSIPPI RIVER	594	GROUNDING	\$1,500.00	4	NOVA 249		NOT NOTED
Victoria	MC95014236	6-Sep-95	545 W.J. BARTA, GROUNDING	LOWER MISSISSIPPI RIVER	594	GROUNDING	\$8,045.00	5	ACBL 3051		PORT QUARTER
Victoria	MC95014236	6-Sep-95	545 W.J. BARTA, GROUNDING	LOWER MISSISSIPPI RIVER	594	GROUNDING	\$8,045.00	5	VIX 7350		STARBOARD QUARTER
Victoria	MC95014236	6-Sep-95	545 W.J. BARTA, GROUNDING	LOWER MISSISSIPPI RIVER	594	GROUNDING	\$8,045.00	5	GLI 106		STARBOARD QUARTER
Victoria	MC95014236	6-Sep-95	545 W.J. BARTA, GROUNDING	LOWER MISSISSIPPI RIVER	594	GROUNDING	\$8,045.00	5	CH 9379		NOT NOTED
Victoria	MC93002448	5-Feb-93	1943 BILL ANDREWS COLLIDED WITH	LOWER MISSISSIPPI RIVER	594	COLLISION	\$35,000.00	4	SC 305 S		PORT MIDSHIP HALF LENGTH
Victoria	MC93002448	5-Feb-93	1943 BILL ANDREWS COLLIDED WITH	LOWER MISSISSIPPI RIVER	594	COLLISION	\$35,000.00	4	SC 305 S		STARBOARD BOW
Victoria	MC94000227	2-Jan-94	1854 LAINEY JONES, GROUNDING	LOWER MISSISSIPPI RIVER	595	GROUNDING	\$22,000.00	4	CBX 223		PORT BOW
Victoria	MC94002593	10-Nov-94	2245 MV JOSEPH RAY	LOWER MISSISSIPPI RIVER	595	GROUNDING	\$28,214.00	5	PV 5977		NOT NOTED
Victoria	MC97013587	21-Sep-97	2325 MV NEBRASKA CITY	LOWER MISSISSIPPI RIVER	598	GROUNDING	\$0.00	2	EFC 9218		STARBOARD BOW
	MC96009621	7-Jun-96	1630 SR KENTUCKY	LOWER MISSISSIPPI RIVER	598	GROUNDING	not noted	3	OR 307		NOT NOTED
	MC96009621	7-Jun-96	1630 SR KENTUCKY	LOWER MISSISSIPPI RIVER	598	GROUNDING	not noted	3	SR BARGE NO. 204		NOT NOTED
	MC96009621	7-Jun-96	1630 SR KENTUCKY	LOWER MISSISSIPPI RIVER	598	GROUNDING	not noted	3	SR BARGE NO. 401		NOT NOTED
	MC96009621	7-Jun-96	1630 SR KENTUCKY	LOWER MISSISSIPPI RIVER	598	GROUNDING	not noted	3	SR BARGE NO. 411		NOT NOTED
	MC96009621	7-Jun-96	1630 SR KENTUCKY	LOWER MISSISSIPPI RIVER	598	GROUNDING	not noted	3	T 3043		STARBOARD BOW
	MC95013208	24-Sep-95	850 MV STONE POWER	LOWER MISSISSIPPI RIVER	610	GROUNDING	\$0.00	3	S 28		NOT NOTED
	MC93020151	4-Nov-93	2155 JOSEPH MERRICK JONES, AGROUND	LOWER MISSISSIPPI RIVER	611	GROUNDING	\$0.00	6	AGS 8278		STARBOARD BOW
	MC93020151	4-Nov-93	2155 JOSEPH MERRICK JONES, AGROUND	LOWER MISSISSIPPI RIVER	611	GROUNDING	\$0.00	6	AGS 6398		STARBOARD BOW
	MC93020151	4-Nov-93	2155 JOSEPH MERRICK JONES, AGROUND	LOWER MISSISSIPPI RIVER	611	GROUNDING	\$0.00	6	AGS 6586		STARBOARD BOW
	MC93020151	4-Nov-93	2155 JOSEPH MERRICK	LOWER MISSISSIPPI RIVER	611	GROUNDING	\$0.00	6	CA527		STARBOARD BOW
	MC93007014	21-Apr-93	990 CGBWATERFRONT #6 & #8 FLEETS	UPPER MISSISSIPPI RIVER	0	BREAKAWAY	NOT NOTED	4	CGB 166	3	STARBOARD BOW
	MC94003309	16-Feb-94	2155 MV BOB STITH 0 UMR	UPPER MISSISSIPPI RIVER	0	COLLISION	\$8,300.00	4	MM 70	3	STARBOARD BOW
	MC94003309	16-Feb-94	2155 MV BOB STITH 0 UMR	UPPER MISSISSIPPI RIVER	0	COLLISION	\$8,300.00	4	ACBL 1287	1	PORT BOW
	MC96013331	28-Aug-96	5 MV JO ANNE STEGBAUER 1.3, UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$750.00	2	N.M.S. NO. 2507	1	PORT QUARTER
	MC98010039	3-Jul-98	2140 MV TWYLA A. 01.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$175,000.00	3	L 2118	10	STARBOARD QUARTER
	MC95005697	7-Apr-95	330 MV TWYLA A. 01.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$175,000.00	3	L-331	10	STARBOARD QUARTER
	MC95005697	7-Apr-95	330 MV TWYLA A. 01.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$175,000.00	3	L-331	10	STARBOARD QUARTER
	MC95005697	7-Apr-95	330 MV TWYLA A. 01.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$175,000.00	3	L-331	10	STARBOARD QUARTER
	MC95005697	7-Apr-95	330 MV TWYLA A. 01.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$175,000.00	3	L-331	10	STARBOARD QUARTER
	MC95007820	12-May-95	150 MV INGLE L. TOLEN 1.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$50,000.00	2	AGS 951	8	STARBOARD BOW
	MC93006463	14-Apr-93	2210 ALL: MV J.M. JONES WCAIRO BR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$30,000.00	3	RB 3	8	PORT MIDSHIP HALF LENGTH
	MC93006463	14-Apr-93	2210 ALL: MV J.M. JONES WCAIRO BR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$30,000.00	3	RBZ 6	8	PORT BOW
	MC93006737	14-May-93	1100 MV CITY OF HUNTINGTON 01.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$40,000.00	3	CBL 306	3	STARBOARD QUARTER
	MC93006737	14-May-93	1100 MV CITY OF HUNTINGTON 01.3 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$40,000.00	3	CR 3029	3	STARBOARD QUARTER
	MC93012770	5-Jul-93	315 MV STEVE T	UPPER MISSISSIPPI RIVER	1	ALLISION	\$86,000.00	2	PV3659	3	STARBOARD QUARTER
	MC93016031	3-Sep-93	2030 MV ALOIS LUHR	UPPER MISSISSIPPI RIVER	1	ALLISION	NOT NOTED	2	L-1021	3	STARBOARD QUARTER
	MC93016494	7-Oct-93	2030 MV RANDY ECKSTEIN 001 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$345,150.00	4	T-7951	3	STARBOARD QUARTER
	MC93016494	7-Oct-93	2030 MV RANDY ECKSTEIN 001 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$345,150.00	4	CC251B	3	STARBOARD QUARTER
	MC93016494	7-Oct-93	2030 MV RANDY ECKSTEIN 001 UMR	UPPER MISSISSIPPI RIVER	1	ALLISION	\$345,150.00	4	CC251B	3	STARBOARD QUARTER
	MC93017019	19-Sep-93	1835 CRIMSON DUKE 02.5 UMR	UPPER MISSISSIPPI RIVER	2	ALLISION	\$345,150.00	4	BUNGE 713	6	STARBOARD MIDSHIP HALF LENGTH
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$85,500.00	4	XL 144	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$85,500.00	4	DANIEL WEBSTER	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	DM 2575	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER MISSISSIPPI RIVER	2	GROUNDING	\$24,020.00	4	SER 182 B	6	STARBOARD QUARTER
	MC93009808	27-May-93	2345 GRD: MV DANIEL WEBSTER 2.4 UMR	UPPER							

Bandway Waiver	Case	Date	Time	Description	Waterway	Mile	Incident Type	Damage	Ves	Vessel Name	Speed	Damage Location
	MC97002883	26-Feb-97	600	78 STCO 226/POTENTIAL 30 UMR	UPPER MISSISSIPPI RIVER	39	GROUNDING	\$2,000.00	2	STCO 226		PORT MIDSHIP HALF LENGTH
	MC97001178	10-Jun-97	1040	NAV NORA PICKETT 41 UMR	UPPER MISSISSIPPI RIVER	40	GROUNDING	\$0.00	2	COASTAL 2003-L		STARBOARD BOW
	MC96013990	12-Sep-96	2150	NAV COOPERATIVE SPIRIT 41 UMR	UPPER MISSISSIPPI RIVER	41	GROUNDING	\$0.00	3	ART 245B		PORT QUARTER
	MC96014048	12-Sep-96	1845	NAV ELIZABETH ANN 41 UMR	UPPER MISSISSIPPI RIVER	41	GROUNDING	\$300.00	2	ART 445		PORT BOW
	MC96014045	17-Sep-96	1335	NAV BETTY LYNN 41 UMR	UPPER MISSISSIPPI RIVER	41	GROUNDING	\$0.00	1	RETT LYNN		STARBOARD MIDSHIP HALF LENGTH
	MC95016539	17-Dec-95	1800	NAV DE LASALLE 41 UMR	UPPER MISSISSIPPI RIVER	41	GROUNDING	not noted	4	OCC 515	0	PORT BOW
	MC95002259	13-Feb-96	200	NAV PRAIRIE DAWN 42 UMR	UPPER MISSISSIPPI RIVER	42	ALLISION	\$30,000.00	4	DM 3032	0	STARBOARD BOW
	MC96018568	24-Dec-96	515	NAV ANN BRENT 42 UMR	UPPER MISSISSIPPI RIVER	42	ALLISION	\$60,000.00	1	PRAIRIE DAWN		STARBOARD QUARTER
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	AARON G	2	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	WRF 58	2	NOT NOTED
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	MM 42	0	PORT QUARTER
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	GENE NEAL	0	STARBOARD QUARTER
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	GENE NEAL	0	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	ITC 118	2	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	STFB 368	2	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	DP 273	2	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	F 13	2	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	C 8 B 209 B	2	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	AGS 338	2	PORT MIDSHIP HALF LENGTH
	MC95002759	18-Feb-95	945	NAV GENE NEAL 42 UMR	UPPER MISSISSIPPI RIVER	42	GROUNDING	\$253,500.00	12	CC-9210	2	PORT MIDSHIP HALF LENGTH
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	SUN 406		PORT BOW
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	CGB 250B		STARBOARD QUARTER
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	TPC 220		PORT BOW
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	ABC 404		PORT QUARTER
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	ABC 404		STARBOARD BOW
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	CC 95130		PORT QUARTER
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	CC 95135		STARBOARD BOW
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	ART 353		STARBOARD QUARTER
	MC97006597	14-May-97	600	NAV BILL ANDREWS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,500.00	25	ACO 126B		PORT BOW
	MC95007821	14-May-95	2030	NAV AMERICAN PILLAR 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$14,950.00	8	ART 353	3	STARBOARD BOW
	MC95007821	14-May-95	2030	NAV AMERICAN PILLAR 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$14,950.00	8	ACO 126B	3	STARBOARD BOW
	MC95007821	14-May-95	2030	NAV AMERICAN PILLAR 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$14,950.00	8	XL 634B	3	STARBOARD BOW
	MC95007821	14-May-95	2030	NAV AMERICAN PILLAR 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$14,950.00	8	AT 675B	3	STARBOARD BOW
	MC95007821	14-May-95	2030	NAV AMERICAN PILLAR 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$14,950.00	8	ART 490	3	STARBOARD BOW
	MC95008048	18-May-95	905	NAV LAINEY JONES 44 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$14,950.00	8	TCB 319	3	STARBOARD QUARTER
	MC95008048	18-May-95	905	NAV LAINEY JONES 44 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	not noted	4	TPC 101 F	3	PORT BOW
	MC95008048	18-May-95	905	NAV LAINEY JONES 44 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	not noted	4	LF 521	3	PORT QUARTER
	MC95011408	13-Jul-95	500	NAV GIRARD LEWIS 43.7 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$98,000.00	4	GOUL 238	3	STARBOARD BOW
	MC93004002	6-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$111,500.00	2	APEX 102X	3	PORT MIDSHIP HALF LENGTH
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$111,500.00	3	RBL 5176	8	STARBOARD BOW
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$111,500.00	3	CJB 290	3	STARBOARD BOW
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	CGB 462B	3	STARBOARD QUARTER
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	DS 6	3	STARBOARD QUARTER
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	DS 9	3	STARBOARD QUARTER
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	PV 550 FLB	3	PORT BOW
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	ABC 423B	3	PORT MIDSHIP HALF LENGTH
	MC93004011	7-Mar-93	1410	ALL T/B BILL ANDREWS -THEBES	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	ML 705B	3	PORT BOW
	MC94018299	1-Sep-94	1625	NAV K.L.J. ERICKSON 43 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	SCF 122	1	STARBOARD BOW
	MC94018299	1-Sep-94	1625	NAV K.L.J. ERICKSON 43 UMR	UPPER MISSISSIPPI RIVER	43	ALLISION	\$132,400.00	9	CBL 332	1	STARBOARD BOW
	MC94018299	1-Sep-94	1625	NAV K.L.J. ERICKSON 43 UMR	UPPER MISSISSIPPI RIVER	43	COLLISION	NOT NOTED	5	EFC 9228	1	STARBOARD BOW
	MC94018299	1-Sep-94	1625	NAV K.L.J. ERICKSON 43 UMR	UPPER MISSISSIPPI RIVER	43	COLLISION	NOT NOTED	5	EFC 9231	1	STARBOARD BOW
	MC94018299	1-Sep-94	1625	NAV K.L.J. ERICKSON 43 UMR	UPPER MISSISSIPPI RIVER	43	COLLISION	NOT NOTED	5	OLD YELLOW	0	PORT BOW
	MC94018299	1-Sep-94	1625	NAV K.L.J. ERICKSON 43 UMR	UPPER MISSISSIPPI RIVER	43	COLLISION	NOT NOTED	5	EFC 9214	1	PORT QUARTER
	MC94018299	1-Sep-94	1625	NAV K.L.J. ERICKSON 43 UMR	UPPER MISSISSIPPI RIVER	43	COLLISION	NOT NOTED	5	CCT 84	4	STARBOARD BOW
	MC96015836	17-Oct-96	340	NAV J.B. KLEINPETER 45 UMR	UPPER MISSISSIPPI RIVER	44	GROUNDING	\$16,000.00	2	OR 1055	3	PORT BOW
	MC96015836	17-Oct-96	340	NAV J.B. KLEINPETER 45 UMR	UPPER MISSISSIPPI RIVER	44	GROUNDING	\$1,000.00	3	OR 1039	3	PORT QUARTER
	MC96018374	14-Dec-96	230	NAV MIDWEST VOYAGER 45 UMR	UPPER MISSISSIPPI RIVER	44	GROUNDING	\$141,962.00	4	OCC 508	3	STARBOARD BOW
	MC96018374	14-Dec-96	230	NAV MIDWEST VOYAGER 45 UMR	UPPER MISSISSIPPI RIVER	44	GROUNDING	\$141,962.00	4	CCB 131	3	STARBOARD BOW
	MC95003664	1-Feb-95	1720	NAV W.A. KERNAN 44 UMR	UPPER MISSISSIPPI RIVER	44	GROUNDING	\$5,000.00	1	W.A. KERNAN		STARBOARD QUARTER

Bandway Weir	Case	Date	Time	Description	Waterway	Mile	Incident Type	Damage	Ves	Vessel Name	Speed	Damage Location
Fountain Bluff	MC98017070	5-Dec-96	318	KAY A. ECKSTEIN (SLMMS)	UPPER MISSISSIPPI RIVER	77	COLLISION	not noted	4	KAY A. ECKSTEIN	12	NOT NOTED
Fountain Bluff	MC97010864	20-Jul-97	430	SR ST LOUIS (SLMMS)	UPPER MISSISSIPPI RIVER	78	COLLISION	not noted	1	SR ST LOUIS		STARBOARD QUARTER
Fountain Bluff	MC96012251	8-Aug-96	225	BILL STEGBAUER/RITA BARTA(STL)	UPPER MISSISSIPPI RIVER	80	COLLISION	not noted	3	HMS 200		STARBOARD QUARTER
Fountain Bluff	MC96011835	23-Jan-96	633	MIDWEST EXPLORER (SLMMS)	UPPER MISSISSIPPI RIVER	83	EQUIP FAIL	not noted	1	RITA BARTA		NOT NOTED
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	CB 41		PORT BOW
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	LF 522		PORT BOW
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	LF 101 B		PORT BOW
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	CA528		PORT BOW
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	BUNGE 112		PORT BOW
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	CGB 2778		PORT BOW
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	SJT 155		PORT QUARTER
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	AGS 431B		PORT MIDSHIP HALF LENGTH
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	ABC 313		PORT MIDSHIP HALF LENGTH
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	CGB 2128		PORT MIDSHIP HALF LENGTH
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	PV 2940		PORT MIDSHIP HALF LENGTH
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	ABC 755		PORT MIDSHIP HALF LENGTH
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	SJT 160		PORT MIDSHIP HALF LENGTH
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	ABC 417		STARBOARD MIDSHIP HALF LENGTH
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$747,500.00	19	CA 127B		NOT NOTED
Fountain Bluff	MC95006735	20-Apr-95	30	NAV FLOYD GOODMAN	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$22,500.00	2	ROBERT GREENE		PORT BOW
Fountain Bluff	MC95000183	10-Dec-94	600	NAV LOUIS H. MEECE	UPPER MISSISSIPPI RIVER	83	GROUNDING	\$10,000.00	3	ACBL 1272		PORT BOW
Fountain Bluff	MC96011838	27-Dec-96	348	INGLE L. TOLEN-778 OCC 514(SLMMS)	UPPER MISSISSIPPI RIVER	84	GROUNDING	\$10,000.00	2	ACBL 2881		PORT BOW
Red Rock	MC95011856	18-Mar-96	2050	CHARLES SOUTHERN	UPPER MISSISSIPPI RIVER	93	GROUNDING	\$1,000.00	2	PC 2805		STARBOARD MIDSHIP HALF LENGTH
Red Rock	MC96004488	16-Mar-96	45	NAV TRANSPORTER (SLMMS)	UPPER MISSISSIPPI RIVER	94	EQUIP FAIL	not noted	9	TRANSPORTER		NOT NOTED
Red Rock	MC96004488	16-Mar-96	45	NAV TRANSPORTER (SLMMS)	UPPER MISSISSIPPI RIVER	94	EQUIP FAIL	not noted	9	CC-8120		NOT NOTED
Red Rock	MC97001847	18-Jan-97	2130	SANDY MCNTUDD/69UMR(SLMMS)	UPPER MISSISSIPPI RIVER	95	COLLISION	not noted	4	NAV CONTI JUDI		NOT NOTED
Red Rock	MC97001847	18-Jan-97	2130	SANDY MCNTUDD/69UMR(SLMMS)	UPPER MISSISSIPPI RIVER	95	COLLISION	not noted	4	VLB 9174		PORT QUARTER
Red Rock	MC96006804	12-Feb-96	1130	NAV LANEY JONES (SLMMS)	UPPER MISSISSIPPI RIVER	95	COLLISION	not noted	4	AGS 914		NOT NOTED
Red Rock	MC95006804	5-Feb-95	1345	NAV J. ANDREW ECKSTEIN	UPPER MISSISSIPPI RIVER	103	GROUNDING	not noted	2	PJ123		NOT NOTED
Red Rock	MC93003035	28-Feb-93	300	KEVIN TOLEN, AGRD 108.2 UMR	UPPER MISSISSIPPI RIVER	108	GROUNDING	\$2,500.00	2	AO 116		STARBOARD MIDSHIP HALF LENGTH
Red Rock	MC93003035	18-Jan-93	300	ALOIS LUHR, ALLISION 109.5 UMR	UPPER MISSISSIPPI RIVER	109	ALLISION	\$48,160.00	8	L 971		STARBOARD BOW
Red Rock	MC93003035	18-Jan-93	300	ALOIS LUHR, ALLISION 109.5 UMR	UPPER MISSISSIPPI RIVER	109	ALLISION	\$48,160.00	8	L-1001		STARBOARD BOW
Red Rock	MC93003035	18-Jan-93	300	ALOIS LUHR, ALLISION 109.5 UMR	UPPER MISSISSIPPI RIVER	109	ALLISION	\$48,160.00	8	GD 905		STARBOARD BOW
Red Rock	MC93003035	18-Jan-93	300	ALOIS LUHR, ALLISION 109.5 UMR	UPPER MISSISSIPPI RIVER	109	ALLISION	\$48,160.00	8	AO 116		STARBOARD BOW
Red Rock	MC96017884	5-Dec-96	1635	KEVIN TOLEN (SLMMS)	UPPER MISSISSIPPI RIVER	109	COLLISION	not noted	5	A F 13		PORT QUARTER
Red Rock	MC96017884	5-Dec-96	1635	KEVIN TOLEN (SLMMS)	UPPER MISSISSIPPI RIVER	109	COLLISION	not noted	5	CGB 357		STARBOARD BOW
Kaskaskia	MC94023558	15-Sep-94	830	NAV ZEUS	UPPER MISSISSIPPI RIVER	110	GROUNDING	NOT NOTED	2	STCO 181 B		PORT BOW
Kaskaskia	MC96008212	10-Jun-96	1235	KAY A. ECKSTEIN (SLMMS)	UPPER MISSISSIPPI RIVER	110	ALLISION	\$600,000.00	23	KAY A. ECKSTEIN		NOT NOTED
Kaskaskia	MC94010707	17-Jan-94	1465	NAV KATHY ELLEN GRND. 116.9 UMR	UPPER MISSISSIPPI RIVER	116	GROUNDING	\$0.00	4	AGS 908		NOT NOTED
Kaskaskia	MC94010707	17-Jan-94	1465	NAV KATHY ELLEN GRND. 116.9 UMR	UPPER MISSISSIPPI RIVER	116	GROUNDING	\$0.00	4	NOMA 310B		NOT NOTED
Kaskaskia	MC93000824	11-Jan-93	1030	NAV BILL STAPP EQUIPOLGRD	UPPER MISSISSIPPI RIVER	145	EQUIP FAIL	\$24,100.00	4	AGS 878B		NOT NOTED
Kaskaskia	MC93000824	11-Jan-93	1030	NAV BILL STAPP EQUIPOLGRD	UPPER MISSISSIPPI RIVER	145	EQUIP FAIL	\$24,100.00	4	S-27		STARBOARD MIDSHIP HALF LENGTH
Kaskaskia	MC94004519	18-Jan-94	1651	NAV BILL ELMER GRNDG UMR 145	UPPER MISSISSIPPI RIVER	145	GROUNDING	\$24,100.00	3	ACBL 301		STARBOARD QUARTER
Kaskaskia	MC95009456	2-May-95	630	NAV BOB STITH	UPPER MISSISSIPPI RIVER	145	GROUNDING	\$0.00	3	AR 803		PORT BOW
Carl Bear	MC96016877	31-Oct-96	600	7B MO. N.M.S. 1952 (SLMMS)	UPPER MISSISSIPPI RIVER	152	BREAKAWAY	not noted	2	BOB STITH		NOT NOTED
Carl Bear	MC96016877	31-Oct-96	600	7B MO. N.M.S. 1952 (SLMMS)	UPPER MISSISSIPPI RIVER	152	BREAKAWAY	not noted	2	N.M.S. NO. 1952		NOT NOTED
Carl Bear	MC95008347	4-Nov-95	1604	CYDESDALE (SLMMS)	UPPER MISSISSIPPI RIVER	164	ALLISION	not noted	1	CYDESDALE		STARBOARD QUARTER
Carl Bear	MC95008347	4-Nov-95	1604	CYDESDALE (SLMMS)	UPPER MISSISSIPPI RIVER	164	ALLISION	not noted	1	TRIPPER		NOT NOTED
Carl Bear	MC95008347	21-May-95	200	NAV TRIPPER/JUB BRIDGE	UPPER MISSISSIPPI RIVER	168	ALLISION	not noted	5	RW21B		PORT BOW
Carl Bear	MC95008347	21-May-95	200	NAV TRIPPER/JUB BRIDGE	UPPER MISSISSIPPI RIVER	168	ALLISION	not noted	5	CHEM 19		PORT MIDSHIP HALF LENGTH
Carl Bear	MC97005723	12-Apr-97	540	HARBOR HUSTLER/70UMR (SLMMS)	UPPER MISSISSIPPI RIVER	170	GROUNDING	\$12,500.00	2	RCC 100		NOT NOTED
Carl Bear	MC95012617	17-Jul-95	510	NAV PHOEBE MERCER GRD. 170 UMR	UPPER MISSISSIPPI RIVER	170	GROUNDING	not noted	9	PHOEBE MERCER		STARBOARD BOW
Carl Bear	MC93008456	14-May-93	530	80 BARGES ADRIFT, MI 171.5 UMR	UPPER MISSISSIPPI RIVER	171	BREAKAWAY	NOT NOTED	9	RW 242		PORT BOW
Carl Bear	MC93008456	14-May-93	530	80 BARGES ADRIFT, MI 171.5 UMR	UPPER MISSISSIPPI RIVER	171	BREAKAWAY	NOT NOTED	9	B-251		PORT BOW
Carl Bear	MC93008456	14-May-93	530	80 BARGES ADRIFT, MI 171.5 UMR	UPPER MISSISSIPPI RIVER	171	BREAKAWAY	NOT NOTED	9	B-270		PORT QUARTER

Bandway Wells	Case	Date	Time	Description	Waterway	Mile	Incident Type	Damage	Ves	Vessel Name	Speed	Damage Location
Bellevue	MC9300458	14-May-93	530	80 BARGES ADRIFT, MI 171.5 UMR	UPPER MISSISSIPPI RIVER	171	BREAKAWAY	NOT NOTED	8	CC-8040		STARBOARD BOW
	MC9300458	14-May-93	530	80 BARGES ADRIFT, MI 171.5 UMR	UPPER MISSISSIPPI RIVER	171	BREAKAWAY	NOT NOTED	8	RM 508		PORT BOW
	MC9300458	14-May-93	530	80 BARGES ADRIFT, MI 171.5 UMR	UPPER MISSISSIPPI RIVER	171	BREAKAWAY	NOT NOTED	9	CC-9220		PORT MIDSHIP HALF LENGTH
	MC9300458	14-May-93	530	80 BARGES ADRIFT, MI 171.5 UMR	UPPER MISSISSIPPI RIVER	171	BREAKAWAY	NOT NOTED	9	CC-8017		STARBOARD MIDSHIP HALF LENGTH
	MC97013306	12-Sep-97	440	KAREN MICHELLE/17UMR (SLMMS)	UPPER MISSISSIPPI RIVER	171	EQUIP FAIL	\$9,544.00	5	CC-232 B		NOT NOTED
	MC97013306	12-Sep-97	440	KAREN MICHELLE/17UMR (SLMMS)	UPPER MISSISSIPPI RIVER	171	EQUIP FAIL	\$9,544.00	5	MR. ED		NOT NOTED
	MC97013306	12-Sep-97	440	KAREN MICHELLE/17UMR (SLMMS)	UPPER MISSISSIPPI RIVER	171	EQUIP FAIL	\$9,544.00	5	WICKSBURG		NOT NOTED
	MC97013306	12-Sep-97	2248	PIC DEATH (2) 171.5 UMR (SLMMS)	UPPER MISSISSIPPI RIVER	171	EQUIP FAIL	\$9,544.00	5	WARREN D		NOT NOTED
	MC97009919	4-Jun-97	2030	ANDREA LEIGH, COL. MI 172 UMR	UPPER MISSISSIPPI RIVER	171	PERSON CAS	\$2,000.00	3	ERC0845A1889		PORT BOW
	MC93000481	4-Jan-93	2030	ANDREA LEIGH, COL. MI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$21,700.00	3	AT 44		NOT NOTED
Bellevue	MC93004398	12-Mar-93	2300	DONALD CARGILL, MCWILLIAN 172UM	UPPER MISSISSIPPI RIVER	172	ALLISION	\$81,000.00	3	CC 9208		STARBOARD BOW
	MC93004398	12-Mar-93	2300	DONALD CARGILL, MCWILLIAN 172UM	UPPER MISSISSIPPI RIVER	172	ALLISION	\$81,000.00	7	HUGH C. BLASKE		STARBOARD MIDSHIP HALF LENGTH
	MC93004398	12-Mar-93	2300	DONALD CARGILL, MCWILLIAN 172UM	UPPER MISSISSIPPI RIVER	172	ALLISION	\$81,000.00	7	R. W. NAYE		STARBOARD MIDSHIP HALF LENGTH
	MC93004398	12-Mar-93	2300	DONALD CARGILL, MCWILLIAN 172UM	UPPER MISSISSIPPI RIVER	172	ALLISION	\$81,000.00	7	AT 6038		STARBOARD BOW
	MC93004398	12-Mar-93	2300	DONALD CARGILL, MCWILLIAN 172UM	UPPER MISSISSIPPI RIVER	172	ALLISION	\$81,000.00	7	TOM FRAZIER		STARBOARD QUARTER
	MC93004398	12-Mar-93	2300	DONALD CARGILL, MCWILLIAN 172UM	UPPER MISSISSIPPI RIVER	172	ALLISION	\$81,000.00	7	ART 505		PORT QUARTER
	MC93004400	13-Mar-93	800	RANDY ECKSTEIN, ALLI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$101,000.00	7	DAVID STEGBAUER		PORT BOW
	MC93004400	13-Mar-93	800	RANDY ECKSTEIN, ALLI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$101,000.00	7	RW 240		STARBOARD MIDSHIP HALF LENGTH
	MC93004400	13-Mar-93	800	RANDY ECKSTEIN, ALLI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$101,000.00	7	RW 187		STARBOARD QUARTER
	MC93004400	13-Mar-93	800	RANDY ECKSTEIN, ALLI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$101,000.00	7	T 3074		STARBOARD BOW
Bellevue	MC93004400	13-Mar-93	800	RANDY ECKSTEIN, ALLI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$101,000.00	7	CC-8054		PORT BOW
	MC93004400	13-Mar-93	800	RANDY ECKSTEIN, ALLI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$101,000.00	7	RW 8348		PORT BOW
	MC93004400	13-Mar-93	800	RANDY ECKSTEIN, ALLI 172 UMR	UPPER MISSISSIPPI RIVER	172	ALLISION	\$101,000.00	7	CC 7908		PORT BOW
	MC97001466	11-Jan-97	1435	HORNET&MIDWEST LEGEND/172 UMR	UPPER MISSISSIPPI RIVER	172	COLLISION	not noted	2	HORNET		STARBOARD QUARTER
	MC95019300	8-Jul-95	2000	NAV PHOEBE MERCER	UPPER MISSISSIPPI RIVER	172	COLLISION	\$100.00	1	PHOEBE MERCER		STARBOARD QUARTER
	MC95014587	19-Sep-95	1535	PAUL MIDDLETON (SLMMS)	UPPER MISSISSIPPI RIVER	172	EQUIP FAIL	not noted	3	PAUL MIDDLETON		NOT NOTED
	MC95018303	9-Oct-95	1115	SENATOR SAMINLAND OIL FLEET	UPPER MISSISSIPPI RIVER	173	ALLISION	\$69,000.00	8	T 3023		STARBOARD BOW
	MC95018303	9-Oct-95	1115	SENATOR SAMINLAND OIL FLEET	UPPER MISSISSIPPI RIVER	173	ALLISION	\$69,000.00	8	SENATOR SAM		STARBOARD BOW
	MC95013751	14-Apr-95	300	WM C. NORMAN COL 173.6 UMR	UPPER MISSISSIPPI RIVER	173	COLLISION	not noted	1	WILLIAM C. NORMAN		PORT QUARTER
	MC97002114	23-Jun-97	1800	DELMAR JAEGER/174 UMR (SLMMS)	UPPER MISSISSIPPI RIVER	174	GROUNDING	not noted	1	DELMAR JAEGER		STARBOARD QUARTER
	MC93007610	22-Apr-93	1800	BARGE RW 213, BREAKAWAY	UPPER MISSISSIPPI RIVER	176	BREAKAWAY	\$2,500.00	1	RW 213	2	PORT QUARTER
Bellevue	MC9606869	25-May-96	245	NAVIGATOR (SLMMS)	UPPER MISSISSIPPI RIVER	177	ALLISION	\$30,000.00	1	NAVIGATOR		PORT BOW
	MC97007642	8-Jun-97	400	F/B RRS 7944/BARTON ST (SLMMS)	UPPER MISSISSIPPI RIVER	177	BREAKAWAY	not noted	1	RRS 7944		PORT MIDSHIP HALF LENGTH
	MC95018008	8-Jun-95	300	KATHLEEN PATER (SLMMS)	UPPER MISSISSIPPI RIVER	177	COLLISION	not noted	1	KATHLEEN PATER		NOT NOTED
	MC96007393	18-May-96	2000	VALLEY SUNSHINE (SLMMS)	UPPER MISSISSIPPI RIVER	177	SINKING	\$400,000.00	2	MARY BURKE		NOT NOTED
	MC96007393	18-May-96	2000	VALLEY SUNSHINE (SLMMS)	UPPER MISSISSIPPI RIVER	177	SINKING	\$350,000.00	2	CB 44		STARBOARD MIDSHIP HALF LENGTH
	MC96007024	12-May-96	1743	EAGLE FLEET BREAKAWAY (SLMMS)	UPPER MISSISSIPPI RIVER	177	SINKING	\$350,000.00	2	CB 44		STARBOARD BOW
	MC97016031	8-Nov-97	2100	MCCANN DEATH/178 UMR (SLMMS)	UPPER MISSISSIPPI RIVER	178	BREAKAWAY	\$95,000.00	11	CCT-28		PORT BOW
	MC97016031	8-Nov-97	2100	MCCANN DEATH/178 UMR (SLMMS)	UPPER MISSISSIPPI RIVER	178	PERSON CAS	not noted	3	AGS 941	0	NOT NOTED
	MC97002576	22-Feb-97	1121	CLYDEDALE/179.2UMR(SLMMS)	UPPER MISSISSIPPI RIVER	179	ALLISION	not noted	2	CLYDEDALE	0	NOT NOTED
	MC96006396	28-Apr-96	1945	SV MISSISSIPPI QUEEN (SLMMS)	UPPER MISSISSIPPI RIVER	179	ALLISION	\$30,000.00	1	MISSISSIPPI QUEEN	10	PORT MIDSHIP HALF LENGTH
Bellevue	MC97003970	6-Mar-97	2310	PEAVEY N. DOCK BRVY/179UMR(SLM)	UPPER MISSISSIPPI RIVER	179	BREAKAWAY	not noted	4	ROBERT Y. LOVE	5	STARBOARD MIDSHIP HALF LENGTH
	MC95005051	5-May-94	100	NAV ROBT Y LOVE, ALL M 180 UMR	UPPER MISSISSIPPI RIVER	180	ALLISION	NOT NOTED	4	MM 7		PORT MIDSHIP HALF LENGTH
	MC95005051	5-May-94	100	NAV ROBT Y LOVE, ALL M 180 UMR	UPPER MISSISSIPPI RIVER	180	ALLISION	NOT NOTED	4	MM 7		PORT MIDSHIP HALF LENGTH
	MC95005051	5-May-94	100	NAV ROBT Y LOVE, ALL M 180 UMR	UPPER MISSISSIPPI RIVER	180	ALLISION	NOT NOTED	4	MM 7		PORT MIDSHIP HALF LENGTH
	MC93022154	28-Sep-93	2330	FAT BREAD ALLISION EADS BRDG	UPPER MISSISSIPPI RIVER	180	POLLUTION	\$32,000.00	2	ACBL 4049		NOT NOTED
	MC94008835	5-May-94	100	ROBERT T. LOVE/EADESBIDGE 160UMR	UPPER MISSISSIPPI RIVER	180	ALLISION	NOT NOTED	1	ROBERT Y LOVE	10	PORT QUARTER
	MC96002316	23-Jan-96	1430	F/B HANNABELLE (SLMMS)	UPPER MISSISSIPPI RIVER	181	BREAKAWAY	not noted	1	HANNABELLE		PORT BOW
	MC96018935	25-Dec-96	639	DELMAR JAEGER (SLMMS)	UPPER MISSISSIPPI RIVER	181	GROUNDING	not noted	2	DELMAR JAEGER	5	NOT NOTED
	MC98000803	24-Dec-97	745	HARBOR HUSTR/182UMR (SLMMS)	UPPER MISSISSIPPI RIVER	182	GROUNDING	not noted	5	SC 1903	3	PORT BOW
	MC97013727	13-Sep-97	1000	KATY PH83UMR (SLMMS)	UPPER MISSISSIPPI RIVER	183	ALLISION	\$10,000.00	5	CC-7835		STARBOARD QUARTER
Bellevue	MC97013727	13-Sep-97	1000	KATY PH83UMR (SLMMS)	UPPER MISSISSIPPI RIVER	183	ALLISION	\$10,000.00	5	RR 202		STARBOARD QUARTER
	MC97013727	13-Sep-97	1000	KATY PH83UMR (SLMMS)	UPPER MISSISSIPPI RIVER	183	ALLISION	\$10,000.00	5	AR 848		STARBOARD BOW
	MC95017487	4-Nov-95	1430	GREENVILLE VIMERCANT BRI	UPPER MISSISSIPPI RIVER	183	ALLISION	not noted	4	GREENVILLE		STARBOARD BOW
	MC95017724	10-Nov-95	1045	NAV PRECURSOR	UPPER MISSISSIPPI RIVER	183	ALLISION	\$90,600.00	7	COASTAL 2522		PORT BOW
	MC95017724	10-Nov-95	1045	NAV PRECURSOR	UPPER MISSISSIPPI RIVER	183	ALLISION	\$90,600.00	7	IB 1806		PORT MIDSHIP HALF LENGTH
	MC95017724	10-Nov-95	1045	NAV PRECURSOR	UPPER MISSISSIPPI RIVER	183	ALLISION	\$90,600.00	7	IB 1806		STARBOARD MIDSHIP HALF LENGTH
	MC95017896	23-Sep-95	535	NAV BILL STAPP	UPPER MISSISSIPPI RIVER	183	ALLISION	\$35,000.00	2	A-28		STARBOARD BOW
	MC95018009	8-Oct-95	1555	NAV W. T. TOUTANT	UPPER MISSISSIPPI RIVER	183	ALLISION	\$500.00	2	ACBL 353X		PORT QUARTER

Bandway Wells	Case	Date	Time	Description	Waterway	Mile	Incident Type	Damage	Ves	Vessel Name	Speed	Damage Location
	MC95020048	19-Dec-95	930	MISS JAN (SLMMS)	UPPER MISSISSIPPI RIVER	183	ALLISION	\$110,000.00	2	MISS JAN		NOT NOTED
	MC94023484	7-Dec-94	300	MAV VIRGINIA ELISON ALLISION	UPPER MISSISSIPPI RIVER	183	ALLISION	\$25,000.00	2	CONSTAL 2022-T		STARBOARD BOW
	MC95018793	29-Nov-95	30	MAV TOM MCCONNELL	UPPER MISSISSIPPI RIVER	184	COLLISION	\$0.00	2	BUNGE 407	5	STARBOARD BOW
	MC95018154	9-Nov-95	1810	CAROL ANN PARSONAGE (SLMMS)	UPPER MISSISSIPPI RIVER	184	COLLISION	\$75,000.00	3	MEM 7534	2	PORT BOW
	MC95018154	9-Nov-95	1810	CAROL ANN PARSONAGE (SLMMS)	UPPER MISSISSIPPI RIVER	184	COLLISION	\$75,000.00	3	ACBL 308	2	STARBOARD BOW
	MC95001288	22-Jan-96	1210	CLYDESDALE (SLMMS)	UPPER MISSISSIPPI RIVER	184	GROUNDING	not noted	1	CLYDESDALE		STARBOARD BOW
	MC95009484	6-Mar-95	1800	MAV KANSAS CITY	UPPER MISSISSIPPI RIVER	184	GROUNDING	not noted	1	MAV KANSAS CITY		STARBOARD BOW
	MC93003036	14-Feb-93	1406	BETSY ROSS, AGRND, MI 184.1	UPPER MISSISSIPPI RIVER	184	GROUNDING	\$5,000.00	1	BETSY ROSS		STARBOARD BOW
	MC97005721	19-Apr-97	2350	STARFIRE/185 5UMR (SLMMS)	UPPER MISSISSIPPI RIVER	185	ALLISION	\$20,000.00	2	ART 385		NOT NOTED
	MC95019363	18-Apr-95	1955	CITY OF NATCHEZ	UPPER MISSISSIPPI RIVER	185	ALLISION	\$150,000.00	2	CECILIA CAROL		NOT NOTED
	MC96018093	25-Oct-96	1420	AUSTIN GOLDING (SLMMS)	UPPER MISSISSIPPI RIVER	190	GROUNDING	\$1,000.00	2	OMR 2771		PORT BOW
Mosenheim	MC96018685	30-Oct-96	1600	LEVITICUS (SLMMS)	UPPER MISSISSIPPI RIVER	190	EQUIP FAIL	not noted	2	AUSTIN GOLDING		NOT NOTED
Mosenheim	MC97016018	15-Oct-97	150	TOM TALBERT/184 5UMR (SLMMS)	UPPER MISSISSIPPI RIVER	193	GROUNDING	not noted	2	J.A.L.6		STARBOARD BOW
Mosenheim	MC97015649	22-Oct-97	710	HARVEST RUN/184 5UMR (SLMMS)	UPPER MISSISSIPPI RIVER	194	GROUNDING	not noted	3	TOM TALBERT		NOT NOTED
Mosenheim	MC97017848	18-Nov-97	345	KJL ERICKSON/184 5UMR (SLMMS)	UPPER MISSISSIPPI RIVER	194	GROUNDING	not noted	2	HARVEST RUN		NOT NOTED
Mosenheim	MC97018014	24-Nov-97	400	ADMIRAL COCKBURN/184 5UMR (SLMMS)	UPPER MISSISSIPPI RIVER	194	GROUNDING	\$40,000.00	2	K.L.J. ERICKSON		NOT NOTED
Mosenheim	MC97017083	18-Nov-97	445	ELIZABETH LANE/184 5UMR (SLMMS)	UPPER MISSISSIPPI RIVER	194	GROUNDING	\$2,500.00	2	WTT 857		PORT BOW
Mosenheim	MC98003709	11-Mar-98	1115	SEBRING (SLMMS)	UPPER MISSISSIPPI RIVER	194	GROUNDING	\$31,300.00	4	ELIZABETH LANE		NOT NOTED
Mosenheim	MC98016223	29-Oct-98	1640	ELIZABETH BEESECKER (SLMMS)	UPPER MISSISSIPPI RIVER	194	GROUNDING	not noted	3	TS-87		PORT BOW
Mosenheim	MC95018784	19-Apr-95	250	STARFIRE	UPPER MISSISSIPPI RIVER	194	GROUNDING	not noted	2	CC-8118	4	PORT BOW
Mosenheim	MC93022164	28-Sep-93	315	COOP VENTURE GROUNDING	UPPER MISSISSIPPI RIVER	194	GROUNDING	\$2,500.00	2	XL 633B		PORT QUARTER
Mosenheim	MC97017084	25-Nov-97	300	HARVEST RUN/185 2UMR (SLMMS)	UPPER MISSISSIPPI RIVER	194	GROUNDING	\$0.00	2	XL 344		NOT NOTED
Mosenheim	MC96001812	24-Jan-96	647	KEVIN FLOWERS (SLMMS)	UPPER MISSISSIPPI RIVER	195	ALLISION	\$6,000.00	2	HARVEST RUN		NOT NOTED
Mosenheim	MC97015724	10-Oct-97	1830	KEVIN FLOWERS (SLMMS)	UPPER MISSISSIPPI RIVER	195	ALLISION	not noted	3	ACBL-2757		PORT QUARTER
Mosenheim	MC97015724	10-Oct-97	1830	SHEILA JOHNSON/195 5UMR (SLMMS)	UPPER MISSISSIPPI RIVER	195	ALLISION	not noted	3	ACBL-4150		PORT QUARTER
Mosenheim	MC86016559	21-Oct-86	500	BOB KOCH (SLMMS)	UPPER MISSISSIPPI RIVER	195	GROUNDING	\$1,275.00	3	ACBL-4150		NOT NOTED
Mosenheim	MC95019699	19-Nov-95	1105	WILLIAM F. PLETTNER (SLMMS)	UPPER MISSISSIPPI RIVER	200	ALLISION	not noted	4	BOB KOCH	917	STARBOARD MIDSHIP HALF LENGTH
Mosenheim	MC93022160	3-Nov-93	1730	CRIMSON GLORY GROUNDING	UPPER MISSISSIPPI RIVER	220	GROUNDING	\$0.00	5	ART 184		NOT NOTED
Mosenheim	MC93022160	3-Nov-93	1730	CRIMSON GLORY GROUNDING	UPPER MISSISSIPPI RIVER	220	GROUNDING	\$0.00	5	SG 824B		NOT NOTED
Mosenheim	MC93022160	3-Nov-93	1730	CRIMSON GLORY GROUNDING	UPPER MISSISSIPPI RIVER	220	GROUNDING	\$0.00	5	SG 865B		NOT NOTED
Mosenheim	MC93022160	3-Nov-93	1730	CRIMSON GLORY GROUNDING	UPPER MISSISSIPPI RIVER	220	GROUNDING	\$0.00	5	SG 354B		NOT NOTED

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				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Waterway Simulation Technology, Inc. 2791 Burnt House Road, Vicksburg, MS 39180				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
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13. SUPPLEMENTARY NOTES					
14. ABSTRACT A typical bendway will be molded in a semi-fixed bed flume. The number of weirs, their spacing and submergence will be varied to determine the effects on tows navigating the reach. The designs will be subjected to a range of current velocities and tow sizes. Final guidance will establish minimum required depths over the weirs and recommended spacing relative to the design size tow.					
15. SUBJECT TERMS <div style="display: flex; justify-content: space-between;"> <div>Bathymetry Bendway weirs</div> <div>Hydrographic survey Low water reference plane</div> <div>Mississippi River Submerged weirs</div> </div>					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 53	19a. NAME OF RESPONSIBLE PERSON
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